

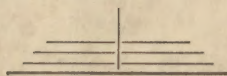
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CONFERENCE on SPINAL CORD INJURIES



19 OCTOBER 1945

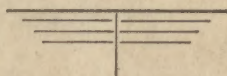
HALLORAN GENERAL HOSPITAL

Staten Island, New York

20 OCTOBER 1945

THOMAS M. ENGLAND GENERAL HOSPITAL

Atlantic City, New Jersey



DOCUMENT SECTION

ARMY SERVICE FORCES
SECOND SERVICE COMMAND

C O N F E R E N C E
O N
S P I N A L C O R D I N J U R I E S

19 October 1945
Halloran General Hospital
Staten Island, New York

20 October 1945
Thomas M. England General Hospital
Atlantic City, New Jersey

A R M Y S E R V I C E F O R C E S
S E C O N D S E R V I C E C O M M A N D

PROGRAM

Friday, 19 October 1945
Halloran General Hospital

MORNING SESSION

Call to Order - Colonel Robert H. Kennedy, MC
Consultant Surgeon, Second Service Command
Presiding

Address of Welcome

Brigadier General C. M. Walson, MC
The Surgeon, Second Service Command

Greeting

Brigadier General Ralph G. DeVoe, USA
Commanding, Halloran General Hospital

Opening Remarks

Colonel Robert H. Kennedy, MC

Overall Policy in ETO

Colonel R. Glen Spurling, MC
Neurosurgical Consultant, Office of The Surgeon General

Ambulation and Support

1. Experience at Halloran General Hospital with Tripod Walking
Lt. Colonel Thomas P. Shearer, MC
2. Experience in Ambulation at England General Hospital
Captain William G. Kuhn, Jr., MC
3. Training in Walking
George G. Deaver, M.D.
Institute for Crippled and Disabled, New York City
4. Muscle Re-education
Miss Blanche Talmud, Physical Instructor
Halloran General Hospital
5. Braces
Captain William G. Kuhn, Jr., MC
T/4 Milton Castor, England General Hospital
6. Discussion opened by Dr. Deaver
7. Discussion closed by -
Lt. Colonel James J. Callahan, MC
Orthopedic Consultant, Office of The Surgeon General.

PROGRAM - continued

The Decubitus Problem

1. Prevention and Dressings
Captain James J. Fitzpatrick, MC, Halloran General Hospital
1st Lt. Dudley F. Grant, MC, England General Hospital
2. Surgical Management of Decubitus Ulcers
Major Edmund J. Croce, MC, Halloran General Hospital
3. Discussion

LUNCHEON

AFTERNOON SESSION

Call to Order - Major Benjamin B. Whitcomb, MC
Chief, Neurosurgical Section, Halloran General Hospital
Presiding

Ward Problems and Ward Management

1. The Ideal Physical Plant
Lt. Colonel Thomas P. Shearer, MC, Halloran General Hospital
2. Ward Management and Detailed Care
Captain William G. Kuhn, Jr., MC, England General Hospital
3. Nursing Problems
1st Lt. Clara L. Ruden, ANC, Halloran General Hospital
4. Discussion

Nutrition

1. The Problem of Nutrition in the Treatment of the Prolonged Hospital Patient
Colonel George G. Duncan, MC
Medical Consultant, Second Service Command
2. Round Table Discussion - Problems of Nutrition
Colonel George G. Duncan, MC
Major Abraham M. Kleinman, MC, Halloran General Hospital
Major Helmuth Sprinz, MC, Halloran General Hospital

Rehabilitation

1. Psychological Readjustment
Colonel Douglas A. Thom, MC
Consultant in Neuropsychiatry, Second Service Command

PROGRAM - continued

2. American Red Cross Service
Mrs. Helen Thirlwall, Halloran General Hospital
Mrs. Anne B. Williams, England General Hospital
3. Occupational Therapy
Miss Ruth Robinson, Occupational Therapy Consultant
Reconditioning Division, Second Service Command
4. The Educational and Shop Program
Lt. Colonel Thomas P. Shearer, MC, Halloran General Hospital
5. Discussion

Saturday, 20 October 1945
Thomas M. England General Hospital

MORNING SESSION

Call to Order - Colonel John H. Lyons, MC
Chief, Surgical Service, England General Hospital
Presiding

Opening Remarks

Brigadier General Sidney L. Chappell, USA
Commanding, England General Hospital

Overall Policy in the Army

Major General Norman T. Kirk, USA
The Surgeon General, United States Army

The Urological Problem

1. The Broader Aspects of the Problem
Lt. Colonel John E. Scarff, MC
2. Experience at England General Hospital
 - a. Physiology and Pathology of the Urinary System
in the Paraplegic Patient
Captain Eric R. Sanderson, MC
 - b. Practice and Results
Captain Robert E. Medler, MC
 - c. Major Urological Complications and their Treatment
in the Paraplegic Patient
Major Samuel L. Raines, MC

PROGRAM - continued

3. Experience at Halloran General Hospital.
Lt. Colonel Thomas P. Shearer, MC
4. Discussion opened by Dr. Donald Munro, Boston, Mass.

Chemical and Biological Aids

1. Experience at Halloran General Hospital
Major Helmuth Sprinz, MC
2. Streptomycin Therapy
Lt. Colonel Thomas P. Shearer, MC, Halloran General Hospital
Major Abraham M. Kleinman, MC, Halloran General Hospital
3. Discussion

Nerve Stimulation by Means of Buried Induction Coil

Major James L. Pool, MC
Chief of Neurosurgical Section, England General Hospital

LUNCHEON

AFTERNOON SESSION

Ward Rounds

Call to Order - Colonel Robert H. Kennedy, MC
Presiding

The Problem of Pain

1. Experience at England General Hospital
Lt. Colonel John E. Scarff, MC
Major James L. Pool, MC
2. Experience at Halloran General Hospital
Major Benjamin B. Whitcomb, MC
3. Discussion opened by -
Captain James C. White, MC
United States Naval Hospital, St. Albans, New York
4. Discussion closed by -
Lt. Colonel Barnes Woodhall, MC
Office of The Surgeon General

PROGRAM - continued

The Problem of Spastic Contractions

1. Experience at England General Hospital
Lt. Colonel John E. Scarff, MC
Major James L. Pool, MC
2. Operative Treatment of Spastic Paraplegic Patients
Lt. Colonel John E. Scarff, MC
Major James L. Pool, MC
3. Experience at Halloran General Hospital
Major Benjamin B. Whitcomb, MC
4. Discussion opened by -
Lt. Colonel Barnes Woodhall, MC
5. Discussion closed by -
Colonel R. Glen Spurling

DINNER AT THE COLUMBUS CLUB

GUESTS

Kirk, Norman T., Major General, USA
 Walson, C.M., Brigadier General, USA
 DeVoe, Ralph G., Brigadier General, USA
 Chappell, Sidney L., Brigadier General, USA

Anderson, Norman W., Colonel, MC
 Beasley, Charles H., Colonel, MC
 Cutler, Condict W., Colonel, MC
 De Bakey, Michael, Colonel, MC
 Duncan, George G., Colonel, MC
 Finney, George G., Colonel, MC
 Kennedy, Robert H., Colonel, MC
 Kirtley, James A. Jr., Colonel, MC
 Lyons, John H., Colonel, MC
 Packard, Edward N., Colonel, MC
 Poer, David, Colonel, MC
 Spurling, R. Glen, Colonel, MC
 Thom, Douglas A., Colonel, MC
 Thorndike, Augustus, Colonel, MC
 Wise, Walter D., Colonel, MC

Brooke, Charles R., Lt Col, MC
 Callahan, James J., Lt Col, MC
 Cordonnier, Justin J., Lt Col, MC
 Elkins, Charles W., Lt Col, MC
 Maltby, George L., Lt Col, MC
 Mayfield, Frank H., Lt Col, MC
 McGibony, Thomas, Lt Col, MC
 Preston, Robert L., Lt Col, MC
 Scarff, John E., Lt Col, MC
 Seidenfeld, Morton A., Lt Col, LAC
 Shearer, Thomas P., Lt Col, MC
 Woodhall, Barnes, Lt Col, MC

Clarkson, P.W., Major, RMC
 Croce, Edmund J., Major, MC
 Elliston, William, Major, MC
 Fisher, William C., Major, MC
 Holtham, William, Major, MC
 Kleinman, Abraham M., Major, MC
 McKinney, William W., Major, MC
 Meyers, Harold R., Major, MC
 Patton, William B., Major, MC
 Petroff, Boris, Major, MC
 Pool, James L., Major, MC
 Prather, George C., Major, MC
 Raines, Samuel L., Major, MC
 Ross, Alex, Major, MC

The Surgeon General, U.S. Army
 The Surgeon, 2nd Service Command
 Commanding, Halloran Gen Hosp
 Commanding, England Gen Hosp

Ashford Gen Hosp
 Deputy SvC Surgeon, 3rd SvC
 Hq, 1st SvC
 SGO, Washington, D.C.
 Hq, 2nd SvC
 Hq, 3rd SvC
 Hq, 2nd SvC
 Hq, 5th SvC
 England Gen Hosp
 Halloran Gen Hosp
 Newton D. Baker Gen Hosp
 SGO, Washington, D.C.
 Hq, 2nd SvC
 SGO, Washington, D.C.
 Formerly, Hq, 3rd SvC

Veterans' Administration
 SGO, Washington, D.C.
 Gardiner Gen Hosp
 Newton D. Baker Gen Hosp
 England Gen Hosp
 Percy Jones Gen Hosp
 SGO, Washington, D.C.
 Hq, 5th SvC
 Formerly, England Gen Hosp
 SGO, Washington, D.C.
 Halloran Gen Hosp
 SGO, Washington, D.C.

Halloran Gen Hosp
 England Gen Hosp
 England Gen Hosp
 Cushing Gen Hosp
 Halloran Gen Hosp
 McGuire Gen Hosp
 Mayo Gen Hosp
 Ashford Gen Hosp
 Newton D. Baker Gen Hosp
 England Gen Hosp
 Ashford Gen Hosp
 England Gen Hosp
 SGO, Washington, D.C.

GUESTS - (continued)

Sprinz, Helmut, Major, MC
Wegner, Walter, Major, MC
Whitcomb, Benjamin B., Major, MC

Brabson, John A., Captain, MC
Cavallaro, William V., Captain, MC
Cliffon, Eugene E., Captain, MC
Donaghy, R.M.P., Captain, MC
Fahlund, George T., Captain, MC
Fitzpatrick, James J., Captain, MC
Garol, Hugh W., Captain, MC
Kuhn, William G. Jr., Captain, MC
Medler, Robert E., Captain, MC
Pollard, Claude Jr., Captain, MC
Potter, Stanley, Captain, MC
Prout, John H., Captain, MC
Pulaski, Edwin J., Captain, MC
Reardon, Frederick, Captain, MC
Sanderson, Eric R., Captain, MC
Seamans, James H., Captain, MC
Skinner, William F., Captain, MC
Smith, George E., Captain, MC
Vanderbeck, James J., Captain, MC
Ward, William C., Captain, MC
Winer, Julius H., Captain, MC
Clark, Felie W., Captain, MDPT
Freeman, Leslie W., 1st Lt, MC
Grant, Dudley F., 1st Lt, MC
Meals, Melvin J., 1st Lt, MC
Ruden, Clara L., 1st Lt, MC

Dalton, Nadylis L., 2nd Lt, MDPT
Lucas, Fred V., 2nd Lt, SnC

Navy

White, James C., Captain (MC) USNR
Hoen, Thomas I., Lt Comdr (MC) USNR
Zesito, R.N., Lt (MC) USNR

American Red Cross

Arnold, Dorothy M.
Cahill, Irene E.
Gates, Harriet
Roth, Eleanor
Sweeney, Marguerite
Pierce, Dorothy L.
Thirlwall, Helen N.
Williams, Anne B.
Zentie, Rose Mary

Halloran Gen Hosp
Newton D. Baker Gen Hosp
Halloran Gen Hosp

England Gen Hosp
Halloran Gen Hosp
Wakeman Gen Hosp
Halloran Gen Hosp
Halloran Gen Hosp
Halloran Gen Hosp
England Gen Hosp
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Wakeman Gen Hosp
England Gen Hosp
McGuire Gen Hosp
Halloran Gen Hosp
Hq, 2nd SvC
Halloran Gen Hosp
Ashford Gen Hosp
Halloran Gen Hosp
Hq, 2nd SvC
Mayo Gen Hosp
England Gen Hosp
Nichols Gen Hosp
Halloran Gen Hosp

England Gen Hosp
Newton D. Baker Gen Hosp

US Naval Hospital, St. Albans, NY
" " " "
" " " "

GUESTS - (continued)

OTR

Jameson, Margretta
Robinson, Ruth A.

England Gen Hosp
Hq, 2nd SvC

E/M

Castor, Milton, T/4
Dittman, Steven, Cpl

England Gen Hosp
" " "

Deaver, George G., M.D.

Institute for Crippled & Disabled,
New York City

Munro, Donald, M.D.

Dept of Neurosurgery, Boston
City Hospital

Talmud, Blanche

Physical Instructor, Halloran
Gen Hosp

SECOND SERVICE COMMAND
CONFERENCE ON SPINAL CORD INJURIES

19 October 1945
Halloran General Hospital
Staten Island, New York

MORNING SESSION

PRESIDING: COLONEL ROBERT H. KENNEDY, MC
Consultant Surgeon, Second Service Command

Address of Welcome

BRIGADIER GENERAL C. M. WALSON, USA, Surgeon, Second Service Command

Brigadier General Sumner Waite, Acting Commanding General, Second Service Command, regrets that required duties elsewhere prevent his being with us. He asked me to express to you his great interest in this conference and the hope that it may be productive of much benefit for our patients. For him and for me, I wish to welcome you to the Second Service Command and hope that you will find everything arranged for your comfort so that this meeting will be of great value to you.

In no previous war, nor in civilian life, has the patient with a spinal cord injury been considered particularly a problem. It has been taken for granted that he was a hopeless cripple and that, from bladder infection with its sequelae, his life expectancy was brief. Nursing care and narcotics were in most instances the main treatment.

The entire attitude has changed in the past three years. We now know that many of these soldiers can be cleared of infection and live as long as any one else, that bed sores can be closed with good tissue, that locomotion is possible, and that jobs can be found for them. These men, whose future has been blasted often by one small shell fragment, deserve everything the Army can give them. Many minds have been at work once it was recognized that the previous pessimistic attitude was unwarranted. Much of the best work has been done by young officers - ward officers who lived with these men and were unwilling to admit that their lot could not be improved. Much work still needs to be done to persuade medical officers more settled in their ideas that these soldiers are not outcasts.

There have been many plans conceived in individual centers which are slow in being spread elsewhere. Two conferences on the subject were held in June 1945 in other commands and an excellent TB MED, No. 162, appeared on this subject in May 1945. But other ideas and changes in emphasis have arisen since. There are many unsettled points still open to argument. There are subjects which seem proved correct to some, but are not admitted as true by others.

BRIG. GEN. C. M. WALSON, USA (continued)

It seemed wise, since there are over 200 patients with spinal cord injuries housed in this command, to ask you men to gather to listen to a presentation of the experience at the two neuro-surgical centers in this command and to discuss freely what is good and what is bad in the assembled data up to this time.

While these patients are housed on neurosurgical sections, we now know that their treatment requires, beside the neurosurgeon, the active interest of the urologist, orthopedic surgeon, internist, laboratory officer, neuropsychiatrist, plastic surgeon, nutrition expert, nurse, physical therapist, reconditioning officer and occupational therapist. We have tried to give some time to each field for discussion of its portion of the problem. It is impossible to place one before another in importance. The result for the soldier depends on how the team functions as a whole.

We are pleased that the Navy and the Veterans Administration are represented here and that the Office of The Surgeon General and 1st, 3rd, 5th and 6th Service Commands have felt it valuable to send representatives in response to our invitation. Except for the problem of transportation we would like to have invited representatives from all the Service Commands. We also welcome especially the invited civilian contributors. I hope this conference will prove of the greatest value to the wounded soldier with a spinal cord injury.

Greeting

BRIGADIER GENERAL RALPH G. DE VOE, USA
Commanding, Halloran General Hospital

I am happy indeed to welcome you here. The purpose and scope of this conference has been so well outlined that I shall not repeat the points which have been brought out. It is stimulating to be engaged in something new. We have been working along these lines for a number of months and have arrived at certain ways of doing things which we think are justified by our results. We realize, of course, that there is going to be a variance of opinions. Criticism of our methods is invited, and we want you to understand that we will welcome this and hope that you will be frank about discussing our approach to the problem. I wish to offer you the complete facilities of this post and hope to arrange things so that you will have nothing on your minds except the business of the conference. We are glad to welcome you and hope to see more of you in the coming days.

Opening Remarks

COLONEL ROBERT H. KENNEDY, MC

Considerable effort is exerted in planning a conference. The time and the topics have been set; the group has arrived. The conference is now yours and its success or failure depends on how

COLONEL ROBERT H. KENNEDY, MC (continued)

actively all of you take part in the discussion and how freely you speak your mind, no matter whose toes are tread upon.

This conference has two purposes, first, to make certain that available knowledge is open to all, and secondly, that every possible idea, which may benefit the soldier with a spinal cord injury, is expressed. It may be just as likely to come from a nurse or a ward officer lieutenant as from the highest ranking officer present.

The war is over. Although there has been little evidence of it as yet, the number of hospital patients will now steadily diminish, until the last war casualty has been made as fit as possible for civilian life. When that time comes and the doors close, there will still be about 1200 young men permanently disabled physically from spinal cord injury, but mentally equally ready to do their part as they were on the day they were inducted into the Army. These men deserve the benefit of every idea that can be conceived to enable them to become the nearest to normal American citizens as is possible. They do not need pampering and sympathy. They don't want it. They want to live as nearly normal lives as can be made practical. The majority will probably become permanent patients of the Veterans Administration institutions. Who is going to tell them that and when?

Meantime each month of the war saw progress in the treatment of these soldiers. These are the men who went to the front line for you and for me. They represent all walks of life, all family situations, all varieties of ambitions. Are they getting the best we know at present at every Army institution? Is there someone who still believes with the Spartans that the crippled person should be put out on the hills to die?

I hope that as a result of this conference there can be further agreement as to basic principles of treatment for these men which can appear in directives, that ideas will be brought out which will be considered worth more trial before a decision is made, and that a better comprehension of the proper relation and emphasis on the many facets of the problem may be gained.

I am personally pleased to see each of you here, old friends and new.

Major General Paul R. Hawley wrote that he would try hard to be present at this conference. He has found it impossible and has asked Colonel Spurling to present the subject assigned to him.

Overall Policy in ETO

COLONEL R. GLEN SPURLING, MC, Neurosurgical Consultant, SGO

General Hawley asked me to express his regrets.

I shall not attempt to give you in detail the management of the paraplegic patient in the European Theater of Operations. Most of it is already known to you. I shall try to indicate to you the broad principles under which we worked.

First, let me say that there is no "ideal" way of handling these patients under field conditions. The pressure of work and the limited facilities of professional nursing and hospital care make this type of casualty the greatest problem of active warfare. Speedy evacuation to a neurosurgical center in the rear echelon is the primary consideration. This is not always possible due to a variety of factors; first, so many of these patients have associated chest and abdominal wounds which preclude early evacuation; second, adverse weather conditions may make roads impassable and close down air evacuation for days at a time; third, over-zealous medical officers too frequently attempt definitive surgery in the forward installations.

The "ideal" care consists of picking up the paraplegic patient from the battalion aid station and taking him to the nearest collection station, placing him in an ambulance bound directly for the nearest evacuation hospital. At this point his general condition is evaluated and treated to prepare him for prompt air evacuation to a neurosurgical center on the continent or in the U. K. Base Section. First aid treatment of his wounds, adjusting his position on the original stretcher to minimize the dangers of pressure sores, and inserting an indwelling catheter to prevent distension of the bladder were the only treatment measures advised.

It was found from experience that the prone position on the stretcher was by far the most satisfactory one, both from the standpoint of comfort of the patient and the prevention of pressure sores. He was taken to the nearest airstrip for prompt evacuation to a general hospital where neurosurgical casualties were concentrated. There he received definitive treatment, consisting in most instances of exploration of the spinal cord with complete debridement of the wound. The main consideration after this had been accomplished was preparing him for evacuation to the Zone of the Interior. This usually required several weeks. During this time, the main considerations were prevention and treatment of urinary sepsis, prevention and caring of decubitus ulcers, and improving the general condition of the patient, keeping/hind primarily the maintenance of a high protein intake.

Only about fifty percent of the cases could be handled in this manner. The remainder had to be cared for in evacuation and field hospitals for the first two or three weeks following injury. If prompt evacuation was impossible, the neurosurgeons in forward installations were instructed to carry out the necessary operative procedures on the spine and to institute as much other definitive treatment as possible under existing conditions.

One time-honored custom had to be radically modified in handling patients with gunshot wounds of the spinal cord - hyperextension of the spine by one means or another. In most of these battle injuries, the danger is primarily to the vertebral arches, the bodies usually remaining relatively intact. Hyperextension under these circumstances is contraindicated because of the danger of pressing the bony fragments further into the spinal canal, thus damaging the cord.

Once the patient arrived in a general hospital, he was put on a special ward where, after the initial surgery was completed, the urologist was placed in charge. The care of the bladder was considered the most urgent problem. In some of the centers tidal drainage was used through an indwelling catheter for two or three weeks post-injury. At the end of this time, if there was no return of spinal cord function, a high suprapubic cystostomy was performed. This was thought to be necessary because it facilitated immediate treatment of urinary sepsis and made the patient available for overseas evacuation in the shortest possible time. Once the wound was well-healed around the cystostomy tube and urinary sepsis had subsided, the patient was considered, from a urological point of view, for evacuation to the Zone of the Interior. We were criticized by certain civilian authorities for using suprapubic cystostomy instead of continuous tidal drainage through an indwelling catheter. It simply is not feasible in an active theater of operation where the chain of evacuation is so long and arduous to use tidal drainage continuously in a large group of casualties. You must remember that from D-Day to V-E Day we treated 1,206 paraplegic patients in the general hospitals of the U. K. Base alone. You can imagine the problems that we would have had with personnel in keeping tidal drainage going in this number of patients. Even though it would have been feasible in our general hospitals there, the system would have undoubtedly broken down when the patient started to the Zone of the Interior by any known form of transportation.

Another factor that the Zone of the Interior surgeons must take into consideration when their paraplegic patients arrived in bad condition is that they might have been in excellent condition when they left ETO general hospitals bound for the Zone of the Interior by ship or plane. Delays incident to any type of evacuation might have kept the patient enroute for two or three weeks, during which time nursing facilities might have been inadequate and the professional care left to the inexperienced officer. However, so far as I know, only one paraplegic patient died enroute from the ETO to the Zone of the Interior, and that one a high cervical injury.

In retrospect, I would say that our main "sin of omission" consisted of too early evacuation to the Zone of the Interior. Were we doing it again we would hold more of these patients in the rear echelon hospitals of the theater until evacuation facilities home were better stabilized. However, you must remember that the pressure for beds was very great; we never knew what the casualty load would be during the active campaign. Our main consideration and primary objective was always returning patients to combat status. The only way to do so was to clear the beds of seriously wounded as quickly as possible, always with due consideration to the best interest of the patient.

EXPERIENCE AT HALLORAN GENERAL HOSPITAL WITH TRIPOD WALKING

LT. COLONEL THOMAS P. SHEARER, MC:

To secure locomotion by means of tripod walking, the patient must stand in braces and propel the lower extremities thru the crutches, using the muscles of the upper extremities and gravity as the propelling forces. The patient must first learn to balance himself in the upright position. This is best accomplished by beginning on the parallel bars. The patient stands in his braces between the bars, holding himself erect with his hands on the bars. After some practice good balance can be secured. The patient then attempts to propel himself by moving his hands forward, lifting his feet from the floor, using the muscles of the upper extremities and allowing the lower extremities to swing by gravity until he is again in the upright position. This is practiced until the patient has "limbered up" and has gained confidence.

The patient is given crutches for the next stage and taught to balance himself and avoid falling forward or backward by moving the crutches in the proper direction. These exercises are practiced until the patient begins to lose his fear of falling and gains confidence.

Two teachers now accompany the patient when he is in the upright position. One teacher stands in front and one in rear of the patient as he makes his attempts at tripod walking. The patient moves the crutches forward, lifts his lower extremities by force directed by the arms and shoulders on the hand bar of the crutch. The lower extremities move toward the crutches until the feet impinge on the floor. The crutches are rapidly brought forward until balance is regained and the maneuver is repeated.

After a great deal of practice the patient is able to swing his lower extremities through and beyond the crutches and with the aid of momentum can execute rather rapid locomotion.

This type of walking is used largely by spastic cases with complete cord lesions as their feet are almost locked together by adductor spasm and constitute one leg of the tripod. After the patient has exercised in this fashion for a time, his spasticity becomes less and often he can move his legs independently and step thru the crutches. In complete lesions of the spinal cord with flaccid paralysis, the patient can move his legs independently by lifting each leg with well developed back muscles and allowing it to swing thru the crutch by gravity. This gives greater stability but is slow and becomes disadvantageous in the dark and on uneven surfaces when the single swinging leg may present the foot in an awkward position making the next step out of alignment, causing the patient to make adjustment with the crutches to regain balance.

LT. COLONEL THOMAS P. SHEARER, MC (Continued)

At Halloran General Hospital we have 57 walking cases. Eight of these cases do some form of tripod walking. Forty-nine cases can do alternate gaits; four of these have complete transection of the spinal cord. A total of 104 cases are now being treated, 56 have braces and 48 do not have braces. There are 12 cases that do not need any support other than for foot drop. It is contemplated that cases with complete lesions will be taught tripod walking, although other gaits will be taught as well. We feel that every case should be taught more than one gait in order to make him more versatile and efficient. For stability in moving about for short distances the legs must be taught to move independently if possible.

EXPERIENCE IN AMBULATION AT ENGLAND GENERAL HOSPITAL

CAPTAIN WILLIAM G. KUHN, MC:

If some calamity were to come upon us in our work and we were forced to give up all but one activity of the many employed in the rehabilitation of paraplegics, the one activity the patient would most desire to have preserved would be ambulation. The question first asked by these men and their families is not "will he get better?"; not "will his bedsores heal?"; nor "will he have sex relations?"; but "will he walk again!". The questioner, of course, presumes that bed sores heal and that since the patient has returned to this country he will get better but they don't ask that; they ask, "Will he walk again?"

At the England General Hospital we have 124 spinal cord injury patients. To date, there are 91 in braces participating in the ambulation program. Of these 124 patients, 12 are cervical, 27 are upper dorsal; 44 are lower dorsal; and 41 are cauda equina lesions; or in percentage, about 10% are cervical; 22% are upper dorsal; 35% are lower dorsal; and 33% are cauda equina cases. Included in the lower dorsal group are 2 amputees; one walking and one transferred from another hospital, not yet ambulatory. There has been a maximum of 122 patients in wheel chairs. Of this 122, between 100 and 111 are constant wheel chair users. There are 11 who occasionally are up in wheel chairs, depending upon their urological status. The percentage of cervical lesions that are walking is 50. There are 63% upper dorsal and 74% lower dorsal walking, and 92% cauda equina lesions walking; 73% of all patients are ambulatory. Of the 91 ambulatory patients, 66 are on ramp and crutches and 25 are on their own.

The ambulation program is under the direct supervision of the ward officer and the physical therapist. The physical therapy staff comprises four lieutenants and three apprentices.

CAPTAIN WILLIAM G. KUHN, MC (Continued)

The phases through which a patient passes in his rehabilitation in walking are:

1. Passive exercise for reeducation of the lower extremities by the physical therapists.
2. Reconditioning of the upper extremities by the Reconditioning Department.
3. Actual attempts at ambulation.

The patient is measured for braces while still classified as a wheel chair or bed patient. Braces are custom made and fitted by the orthopedic brace shop either in bed or in the brace shop, where an overhead trapeze bar and an examining table have been installed. All lesions below T-10 with preservation of quadratus lumborum muscles are given walking calipers without pelvic bands. Those above T-10 are given pelvic bands or thoracic cages, if it proves necessary after a trial period of walking. These braces will be discussed in detail later this morning.

The patient is placed on his feet, in braces, with the aid of two corpsmen, and takes one or two steps. The braces are readjusted on the spot if necessary. The patient is then placed, with his braces on, in a standard Army walker. He is first of all acclimated to the vertical position. He is then taught principles of balance, the results of proper and improper use of this facility. Use is made of the patient's previous athletic experiences and analogies employed, for example, boxing, golf, basketball. The patient is next taught to use his reeducated and reconditioned abdominal and back muscles (that is the quadratus lumborum and abdominis rectus) to shift weight, hike a hip, and swing a leg through, approximating the normal manner. High dorsal lesions will require the tripod method.

The next phase is the actual employment of the "step thru" gait on a walking ramp constructed to the same specifications as those used by all amputation centers. Mirrors are placed at either end and paralleling the ramp and patients check themselves for posture and smoothness during ambulation. The patient is taught forward, backward, and sideways walking. When proficiency develops on the ramp, the patient is given crutches. The "step thru" gait is continued and the patient is taught, in addition, to mount curbs and steps and to manipulate himself in and out of a model car on the ward. When these feats have been accomplished, the patient may proceed to the ambulance garage and take driving instructions for certification and license in the driving school endorsed by all motor vehicle bureaus. The patient is also taught the "swing thru" gait in order that he may have two gaits in forward walking besides his backwards and sideways methods.

We have found that there are many psychological factors present in bringing a comparatively recently injured soldier between the ages of 19 and 25, through the various stages of recovery and realization of the nature of his injury, to attempts at ambulation. He has not been bedridden for a long time, — usually 3 to 6 months after injury. He wants right NOW to walk again as nearly as possible to the way he did when he entered the service. He is not concerned with any speed and distance relationships. To keep a man trying his utmost, we found it better to let him do what he wants to most, — this he always does best.

The "step thru" gait, I believe, is harder to accomplish, but if mastered, it produces two things, — one, a smoother, more natural way of walking, and secondly, it builds up adjacent muscle groups so that dependance upon heavy or bulky pelvic bands, hard to conceal with clothing, is unnecessary. Furthermore, when and if a patient does show recovery thru reeducation of muscle groups by physical therapist the transition to a drop foot brace is accomplished more readily and the patient will not have to learn the step thru gait. He has already mastered it!!! This is particularly true of the low dorsal and cauda equina injuries. Once having mastered the "step thru" gait the patient can learn the "swing thru" gait with ease and will have no compunction if he later on in life sees another paraplegic using a different method of walking. The time to learn is the present, and I feel that the most difficult steps should be mastered while everything is at their disposal. It is also necessary that these patients be able to vary their gaits to meet situations. The "step thru" gait allows for more safety than swing thru gait on wet pavements or slippery surfaces, because these patients do not have any proprioceptive nor cutaneous sensations. The "swing thru" gait is valuable for covering distance quickly.

How these patients will feel about step thru and swing thru gaits five years from now no one is prepared to say. These cases have been made ambulatory earlier than most civilian cases were prior to this war. What they will accomplish with years of practice remains to be seen and not predicted for them!

(Showing of motion picture film.)

We have brought with us a film of approximately 1000 feet that is used primarily for patient consumption. This film was in production before V-J Day, in anticipation of a large number of spinal cord injuries following the invasion of Japan. Its purpose was to acquaint the new arrival, and to refresh the minds of the older patients, with readjustments to the care and rehabilitation of spinal cord injuries. This film, we regret to say, is not complete at this time, as there are 500 more feet of film including upper dorsal lesions on ambulation and reconditioning to be returned from Eastman Kodak Company.

Much credit is due to Corporal Steven Dittman, of the Medical Photography Laboratory of England General Hospital, for the production of this film and the many long hours he spent editing it.

The film shows the stages of rehabilitation of the patient from the moment of entrance to the hospital until his discharge back to civilian life. I trust that you will bear in mind that this film was planned entirely for lay consumption and therefore many professional angles have been omitted or quickly passed over.

TRAINING IN WALKING

GEORGE G. DEEVER, M.D., Medical Director,
Institute for Crippled and Disabled, New York City

Exercises, performed in bed, in the wheelchair or on the mat, have as their primary purpose the preparation of the patient for ambulation and self-care. In order to perform such feats, as standing upright and walking on crutches, special muscular development is needed. The five muscle groups particularly needed for manipulation of crutches are, in order of their importance:

1. Flexors of the arms to move the crutches forward.
2. Extensors of the forearms to hold the elbows stiff, so that they do not buckle when the weight of the body is placed on the hands and when the body weight is raised from the floor.
3. Finger and thumb flexors to prevent grasping the crutches.
4. Dorsiflexors of the wrist to keep the hands in correct position on the hand pieces.
5. Shoulder girdle depressors and downward rotators to support the body by means of the crutches when it leaves the floor.

Patients with complete transverse lesions of the cervical spinal cord will be unable to walk on crutches because the nerve supply of these muscle groups are from the cervical cord. Long double leg braces are necessary before a paraplegic patient can stand or travel with his crutches. It is my personal observation that the army has not given sufficient attention to the construction and fitting of braces and crutches for these patients. Properly fitted braces of strong but light material; extension crutches made from well seasoned strong wood, adjusted as to length, the

position of the hand pieces, and suction tips are prerequisites for ambulation. A knee lock on a brace that fails to lock on standing, a crutch that breaks or slips, increases the fear of the patient and delays rehabilitation.

The demands of crutch walking are heavy. The skills necessary for crutch walking require instruction in the fundamentals before the first attempts at performance. Many hours are spent in standing exercises with a gym bar or other supports; walking exercises between parallel bars and standing exercises with crutches*.

When the patient has gained strength and skill in these fundamental exercises he is ready for crutch walking. All crutch walkers should have at least two gaits, if possible, a fast one to be used in the open for making speed, and a slow one for crowded places. Most of the paraplegic cases resulting from spinal cord injuries have no sensation in their lower extremities and often contend that they cannot feel their feet on the ground and therefore cannot be expected to keep their balance. They can definitely learn to become aware of balance if they are willing to develop sensitivity of the armpits, of the rib cage below the armpits against which the crutches lean, and of their whole upper extremities. Sensation for balance can thus be highly developed. CRUTCH GAITS: There are seven common crutch gaits. The selection of the gaits to be used depends upon the disability of the patient. In the paraplegic patient with complete flaccid or spastic paralysis of the lower extremities and strength in the arms and shoulder girdle, the following procedures have been found most successful:

The patient stands with the crutches placed apart and slanted well forward at their lower ends while the body of the patient is inclined forward at its upper part, with the feet well behind. This is the starting position of the tripod gaits.

a. Tripod Alternate Crutch Gait; Crutch - Foot Sequence

(1) Right crutch (2) left crutch (3) drag body forward

b. Tripod Simultaneous Crutch Gait; Crutch - Foot Sequence

(1) Both crutches (2) Drag body

The tripod simultaneous gait differs from the tripod alternate gait in that the two crutches are placed on the floor at

* Deaver, George G. and Brown, Mary Eleanor. The Challenge of Crutches II. Crutch Walking. Muscular Demands and Preparation. Arch. Phys. Med. 26:515 (Aug. 1945)

once. The body is jerked, dragged, or slid along the floor and the crutches lifted once more. It is a sort of rocking backwards and forwards between crutches and feet. They are the crutch gaits of choice to start paraplegia patients but they are slow, labored and lack grace. The next step is to have the patient learn the swinging crutch gaits. There are two variations: the swinging-to gait and the swinging-through gait -

a. Swinging-to Crutch Gait--Crutch - Foot Sequence

(1) Both crutches (2) lift and swing body to crutches

b. Swinging-through Crutch Gait--Crutch - Foot Sequence

(1) Both crutches (2) lift and swing beyond crutches

The swinging-to gait is the easier and consists in the subject's placing the two crutches simultaneously in front of the body, bearing down on the crutches and lifting the body so that it moves up to the crutches. The swinging-through gait is the more difficult one, because the body is swung through the crutches and lands on the ground ahead of them. The crutches are then placed in front of the body and the gait is continued. Greater speed can be made with this crutch gait than can be attained by a normal person in walking. It is the crutch gait of choice for the paraplegic patient.* Patients with good strength in the quadratus lumborum are able to use the four-point alternate gait:

Four-point alternate gait--Crutch - Foot Sequence

(1) Right Crutch (2) Left Foot (3) Left Crutch (4)
Right Foot

The four-point alternate is the most elementary standard crutch gait and consists in advancing one crutch, then the opposite foot, then the other crutch and finally the other foot. It is a safe gait because there are always three points of support on the floor. It is a slow gait because weight must be constantly shifted. It does not require a great deal of space, so that it is a good gait to use in crowds or where space is limited.

(The talk was followed by a demonstration by patients)

*Deaver, George G. and Brown, Mary Eleanor. The Challenge of Crutches. III. Standard Crutch Gaits and How to Teach Them. Arch. Phy. Med. 26:574 (Sept.) 1945.

MUSCLE RE-EDUCATION FOR PREPARATION FOR AMBULATION

MISS BLANCHE TALMUD, Halloran General Hospital

In conjunction with and prior to the time that the patients are exercised in preparation for ambulation, massage, passive and active exercises, electric and hydrotherapy are given daily by the staff of the physical therapy department under the direction of Captain H. Herman, as indicated by the medical staff.

Fundamental exercises are given for the purpose of developing and strengthening groups of muscles used for body movement, coordination and balance necessary for locomotion and self-care activities.

There are five stages of fundamental exercises:

1. bed exercises
2. wheel-chair exercises
3. mat exercises
4. standing exercises in parallel bars
5. crutch-balancing exercises

Each group of exercises leads up to functional activities, which the patient must perform in order to meet the physical demands of daily living; for example, when a patient is able to sit erect and balance himself some of the functional activities he is asked to perform are: to wash his hands and face, to shave, to comb his hair and put on his socks and slippers.

Daily records showing the progress of each patient are kept under the following headings: date, exercises performed, daily achievements, attitude of the patient, comments and further recommendations of the technician.

The patients, when ready for wheel-chair and mat exercises are required to exercise daily. Those who walk in braces and with crutches are required to come out twice a day, - to exercise on the mat in the morning and to have walking exercises in the afternoon.

We will demonstrate some of the fundamental exercises of each stage -

DEMONSTRATION OF EXERCISE PROGRAM

I. Bed Exercises

1. Grip exercise for strengthening the thumb and finger flexors for grasping crutches.

2. Flexion of the arms, (with and without weights) to strengthen the flexors of the arms in order to lift and move the crutches forward.

MISS BLANCHE TALMUD (continued)

3. Extension of the forearms from a flexed position to strengthen the extensors of the forearms in preparation for straightening the elbows.

4. Extension of the forearms by coming into a sitting position, while pushing the hands on the bed in such a way as to straighten the elbows and taking the weight on the hands.

5. Moving from bed to wheel-chair with little assistance is a good exercise and brings into use many muscles needed in crutch-walking.

II. Wheel Chair Exercises

1. Push ups in wheel-chair, for strengthening the shoulder girdle muscles and the extensors of the forearms, in preparation for depressing the shoulder girdle and straightening the elbows necessary for maintaining the correct hand positions on the crutches.

2. Methods from wheel-chair to mat. Six methods according to the patient's ability.

- a - Ramp to floor.
- b - Benches to floor.
- c - Direct from wheel-chair to floor.
- d - Hall ramp to platform.
- e - From wheel-chair to platform feet first as to an ordinary bed.
- f - From wheel-chair to platform, from the side, which leads into getting from a wheel-chair to an ordinary chair.

III. Mat Exercises

1. Rolling from side to side in preparation for rolling over, useful in developing the trunk muscles and accelerating the circulation.

2. Bending forward for developing the abdominal muscles. (4 positions each)

3. Sitting up using elbows and hands.

4. Pushing up on hands and moving to edge of mat, placing leg over edge. (Can also be done on bed)

5. Balancing, in preparation for balancing when standing on crutches and for putting on work shoes and braces:

- a - Hands on thighs
- b - Arms forward

MISS BLANCHE TALMUD (continued)

- c - Arms sideward
- d - Arms overhead
- e - Touch knees
- f - Touching toes

6. Abbreviated crutch exercises for strengthening the extensors of the forearms, dorsiflexors of the wrists, shoulder girdle depressors and downward rotators in preparation for the use of crutches in a standing position.

- a - Swaying from right to left
- b - Pushing down on crutches and taking weight on hands, lowering body slowly
- c - Raising crutches and putting them down quickly
- d - Moving forward on crutches
- e - Placing crutches forward and backward, rolling over to prone position.

7. Arching back, for strengthening the back muscles.

8. Pushups for strengthening the flexors of the arms, extensors of the forearms and dorsiflexors of the hands. Lowering should be done slowly.

9. Exercises in four legged position, for strengthening the flexors of arms, extensors of forearms and dorsiflexors of hands, for keeping the back flexible for strengthening the abdominal muscles and for adjoining the body so as to maintain balance when removing one point of support:

- a - Raising and lowering back
- b - Raising and lowering right hand
- c - Raising and lowering left hand
- d - Raising and lowering right leg
- e - Raising and lowering left leg

10. Crawling, in preparation for the four point walk on crutches.

11. Pulley exercises for abducting lower extremities in severe spastic cases.

IV. Standing Exercises in parallel bars for adjusting body so as to maintain an upright position and feel a sense of stability.

1. Balancing

- a - Raising and lowering right hand
- b - Raising and lowering left hand
- c - Raising and lowering both hands

MISS BLANCHE TALMUD (continued)

2. Walking forward in preparation for 4 point and 2 point walk on crutches.

3. Pushups, keeping shoulder girdle down, and lowering slowly for strengthening shoulder girdle depressors, downward rotators, extensors of forearms and dorsiflexors of hands.

4. Swinging forward between parallel bars in preparation for the swinging through gait on crutches necessary for walking where speed is the object.

BRACES

CAPTAIN WILLIAM G. KUHN, JR., MC, England General Hospital

The question of braces for use in training the paraplegic in ambulation has brought to light some interesting facts. First of all there is no good, up-to-date, comprehensive, authoritative text on the subject. The best book available on the subject is that of Jordan published in 1937.

This void in publications in regard to braces for the paraplegic is due to two factors. First, until the present war there was no need for such a book. The incidence of spinal cord injuries in civilian life is relatively low as compared with war times. Due to the increased efficiency of the Medical Department in the placing of highly skilled specialists near the front lines, the speed of evacuation and the advent of sulfonamides and penicillin, the absolute number of spinal cord injuries returned to this country has increased. Secondly, until recently the only type braces made were those of steel. Due to the development of a lighter, but equally as strong for the purpose, metal alloy, stereotyped methods and designs of brace have been outmoded. Now that ambulation in paraplegics is here to stay, I think the subject of braces should be opened for discussion.

The paraplegic, in practically all cases, does not have any deformity of the skeletal make up of his lower extremities. His difficulties are with the neuro-muscular systems. Therefore, his braces need not be of weight-bearing type using the ischial weight-bearing ring. He needs, in effect, splints to immobilize his knee joints and a stop of some type to prevent his foot drop from dragging when walking. This could be accomplished by an arthrodesis, but would leave the patient in a sad way for sitting up in a wheel chair.

At England General Hospital we have gone through the stages of empirical planning. When the paraplegics were first up on their feet in January of this year, we used braces of

medium weight steel. Our braces have always been of the walking caliper type rather than the stirrup type. Very few of the patients use pelvic bands. These are employed only after repeated trials convince us the patient must have them. We used the caliper type brace for two reasons.

1. Economy.

The caliper type brace permits the patient to own a single pair of shoes that will suffice him either with or without his braces.

2. Ease of removal.

The caliper type brace may be removed and reapplied without difficulty.

The reasons for our attitude in not using pelvic bands are: First, many patients do not need them. Our prime purpose is to salvage, overtrain, and reeducate everything that is left to the patient following the injury to his spinal cord. The pelvic band hinders this purpose. You are all probably familiar with training methods of professional football players---or at least have heard of them. Players never use ankle wraps during practice sessions. They do wear them the day of the game. Why? Ankle wraps do not prevent strains nor fractures. They will prevent a simple fracture from becoming compounded. Pre-season training and exercise of the ankles strengthens them. So with pelvic bands....they do not allow for strengthening of the preserved muscles. Furthermore, in the event that return of function does occur, we have lost much valuable time in training the leg muscles, and in some cases, may miss the fact that the patient is getting recovery.

Secondly, in the step through method of walking, it does not permit the patient to approach the natural pace in walking. In the upper dorsal lesions where the quadratus lumborum does not function, it, of course, may be necessary to use a pelvic band or thoracic cage.

In using light weight steel for our braces in the beginning, we thought we had made strides. However, very shortly thereafter, Sergeant Castor produced a duraluminum brace for us. Because we had anticipated that we would be acting on an empirical basis and that some of our patients would show recovery and no longer require walking caliper braces, we did not use drop lock joints at the knees. After much testing with the duraluminum braces, we have come to the conclusion that the best walking caliper brace is of duraluminum shanks with a drop lock at the knees and a fixed stop for the foot to prevent drop foot interfering with ambulation. We have found, through experimentation, that we could maintain the continuity of dura-

CAPTAIN WILLIAM G. KUHN, JR., MC (continued)

luminum through the drop lock at the knee by using Gorman silver facings at the hinge joint and steel facing at the drop lock joint. We believe these braces are lighter, more comfortable, and more economical for the patient while he is in the Army and after his discharge.

A pair of duraluminum walking caliper braces with drop lock at knees and foot stop without shoes weighs 1 lb., 9 oz., with shoes 2 lbs., 9 oz.

We have accumulated a number of braces made at other hospitals from patients being transferred closer to home. One such brace, a walking caliper of the stirrup type with drop lock at the knees and a pelvic band, weight 13 lbs., 2 oz.

SPECIAL BRACES AND DEMONSTRATION:

A. Thomas collar of duraluminum construction and leather padding. It is light, form-fitting, and gives a constant support. It may be worn under the clothing. It cannot be loosened by the patient as the common type of brace with its 4 hand-adjusted spreaders.

B. Taylor back brace. Made of duraluminum, it is light and more likely to be worn by the patient and not discarded. It is easily molded to conform to the anatomy of the patient and to avoid any defects on the skin, such as decubiti.

C. Walking caliper with thoracic cage for high dorsal lesions. The thoracic cage is made of duraluminum and heavy wire, and the walking caliper is made of light steel. The thoracic cage is hinged at the pelvis to the walking caliper. There is a drop lock knee joint operated by a guy wire, similar to those used in airplane controls. The guy wires are connected at the knee joint and operated from the hip level. Total weight without shoes is 9 pounds.

D. Ischial weight-bearing stirrup braces for amputees. This brace is made of light weight steel and can be equipped with drop lock at the knee. Trestle supports are built within the brace below the level of the stump. An artificial foot and shoe is permanently attached to the brace. A pelvic band of very light weight and pliable leather connects the Ischial weight-bearing brace to the trunk.

E. The foot drop spring for cauda equina lesions. Heavy steel wire that can be fitted on any shoe, preferably low quarters, with duraluminum strap fitting over gastrocnemius muscle. Total weight 9 ounces.

F. Drop foot brace acquired from patient transferred from another hospital. Made of heavy steel, multiple hinges permanently

CAPTAIN WILLIAM G. KUHN, JR., MC (continued)

attached to shoe. Total weight 2 pounds, 9 ounces.

This demonstration shows, by the simple expedient of the ability to pass all forms of duraluminum braces among the audience, the terrific handicap these patients have added to their primary one of paraplegia if heavy steel braces are used.

DISCUSSION:

DR. DEEVER:

The purpose of the rehabilitation program for paraplegic patients with spinal cord injuries is to prepare them to walk and to travel and care for their daily needs so that they may become useful citizens. I think we agree on the necessity for good braces and crutches, an exercise program which prepares them for walking and traveling and the need for the patient to learn two crutch gaits. We must not forget that life outside the hospital will be far more strenuous than in the hospital. At the Institute for the Crippled and Disabled we test our trainees in the thirty-seven activities inherent in daily living. If they cannot get up curbs, bus stops, cross a street on a green light or get up from the ground, if they fall, they are taught how to perform these activities.*

It has been found that the spasm in many cases is relieved by braces and this fact should be considered before attempting a rhizotomy. The procedure I have found most successful is to teach the patient to walk with braces and crutches as soon as possible. Each day the physical therapist massages the limbs and gives muscle reeducation exercises. If muscle power returns the braces are discarded but if there is no return of muscle function the patient has benefited from his daily activities and is far along the road to rehabilitation. It is better to work with patients than on them for action absorbs anxiety.

2ND LT. NADYLIS T. DALTON (MDPT), England General Hospital:

There has been much said about re-education of the upper extremity, but nothing regarding the lower extremities. At England General Hospital we think a most important consideration is the lower extremity. The soldiers want to walk with their legs and not their arms, if they can help it. The men forget how to use their legs. If motion comes back, fine. The P.T. must teach him what he is supposed to use. Suppose a man has a flicker in the muscle. He may not know he has it, but the P.T.

*Deever, George G. and Brown, Mary Eleanor. Physical Demands of Daily Life. An objective scale for rating the orthopedically exceptional. Institute for the Crippled and Disabled, New York. Studies in Rehabilitation, No. 1.

2ND LT. NADYLIS T. DALTON (MDPT) (continued)

working with him knows he has it and can help him use it and develop it. First they have traces and if you exercise these and bring them up in strength you can get a man to go from a long caliper brace to a drop-foot brace and in some cases, much advanced, no brace. 91 soldiers are walking out of 124, only one not using his quadriceps muscles.

LT. COLONEL ROBERT L. PRESTON, MC,
Orthopedic Consultant, Fifth Service Command:

How is the problem of overfatigue controlled in these patients? We know we have two problems, one to get the patient motivated well enough, and the other to keep the one with much weakened muscles from overfatigue. If these patients are started on a schedule, if they are carefully classified and activities planned during the day, how much time can they spend on these various exercises?

COLONEL CONDUCT W. CUTLER, MC,
Consultant Surgeon, First Service Command:

There are now 86 paraplegic patients at Cushing General Hospital. A full time staff including two qualified physical instructors and 19 WAC's supervise the patients in groups, first in exercise to build up their arms and in gaining balance, then in the use of braces and crutches for walking. This program has been in effect approximately two months. Forty-four patients have been equipped with satisfactory braces to date. There are 30 partial paraplegics walking with crutches and/or braces. There are five partial paraplegics walking without braces. There are 12 complete paraplegics walking with crutches and braces. The outlook is good for the establishment of independent mobility in most of the patients. The calipers in use are steel braces attached to low quarter shoes; they extend to the ischial tuberosity; are fitted with thigh and leg straps and leather knee caps; they have a joint at the knee which is easily locked by the patient; metal foot-drop stops are a standard attachment. Measuring for and provision of braces is accomplished by the Orthopedic Section.

CAPTAIN KUHN:

The problem of the best braces for use in the Army must still be settled. Our duraluminum brace has steel facings at the knee lock and german silver in the knee joint. It has only 3/4" x 1" of steel facing at the drop lock. Duraluminum can be found in any airplane dump and can be obtained for nothing. Duraluminum will give, stretch, and return without breaking. A steel brace snaps if too much weight is placed on it. How much is spasm diminished when the man is up on braces? I have not found that spasm is relieved or diminished by using braces. The crutches demonstrated by us today are standard Army crutches, using a rubber crutch tip. They are good.

MAJOR WHITCOMB:

In partial paraplegia, there has been a definite diminution in spasticity with movement. In complete paraplegia we have not seen any improvement as a result of exercise.

LT. COLONEL JAMES J. CALLAHAN, MC, Orthopedic Consultant, SGO:

We are all in agreement so far as exercise and training are concerned. The only point where there seems to be any question is the problem of braces. I take exception to the statement that our braces are "atrocious". In traveling over all service commands, I think we have better braces than the civilians have. We employ the best men we know. As to the cost, that has never been a problem. We all know that the soldier has to have the best to facilitate his recovery. Personally, I do not think it necessary to go outside of the Army to buy braces. We have all the equipment and material and I do not see why we cannot make the best braces possible. We have a research problem at the present time for which the Government has donated the money, and the aluminum men and the brace men have been asked to come forward with problems, but few did. We have an aluminum brace which is equal, if not superior, to any which can be bought. It is in the preliminary stages and I believe that within a short time it will be available to all. If the centers do not have aluminum, it is on the list and they can get it. The improvements I saw here can be attached to our braces. At the present time the Pope Foundation is working on a drop-foot brace which can be incorporated into an aluminum brace. I agree with Dr. Deaver that these are not just braces, but prostheses, as they have to wear them the same as an artificial arm or leg.

PREVENTION AND DRESSINGS

CAPTAIN JAMES J. FITZPATRICK, MC, Halloran General Hospital:

One of the most common complications found among paraplegics is the decubitus ulcer, or "bed sore", as it is more commonly called. Approximately seventy-eight (78%) per cent of all paraplegics admitted to this hospital from overseas stations or from other hospitals in the states have decubitus ulcers on admission or give a history of having had decubiti upon arrival at other hospitals in the United States. Some of these cases have been several months on the way from overseas stations, others only a few weeks. Nevertheless, the picture is usually the same - large, sloughing, infected decubiti over the sacral region, in the greater percentage, less often over the trochanters and other bony prominences. These ulcers may vary in size from that of a silver dollar to a large dinner plate, involving the entire lumbosacral region.

These observations bring to mind the questions: "What are the causes of these ulcers, and what can be done to prevent them or minimize their occurrence?" This type of ulcer is usually the result of pressure on the skin and underlying tissue, causing interference with the local blood supply, which results in an area of necrosis of the tissues involved. Some of these ulcers may begin superficially and extend into the underlying tissues, while others may begin at the fascial plane and extend to the skin. Further, decubitus ulcers are usually found over the bony prominences of the sacrum, trochanters, and iliac spines, in patients who are in the recumbent position and unable to move about or shift themselves from side to side. Time also is a factor in the formation of decubiti. I recall one patient who was brought in by air. He was twenty hours on the plane, and the banking of the plane with slight shifts of the patients weight against the trochanters was sufficient to cause decubiti. When the patient arrived at the hospital, there were large cyanotic areas over both trochanters which later broke down and formed decubiti. This occurs in the paraplegic since he has no sensation of pain in the affected area, due to his spinal cord injury, to warn him of the beginning of the ulcer. These ulcers are usually grossly infected with organisms which are also cultured from the urinary tract - the coliform group, aerogenes, proteus, gamma streptococci, staphylococcus, K. pneumoniae (Friedlander's) and on occasion B. Welchii. There is gross contamination from fecal matter excreted from the incontinent bowel and spread over the skin of the sacral area and buttocks plus organisms from the external surroundings.

From the foregoing it is evident that the prevention of these ulcers in the paraplegic patient is a matter of major importance. It requires conscientious nursing care and constant watchfulness of the patient; first, to prevent decubiti, and second, if a beginning ulcer is noted, as can be seen by skin discoloration and bleb formation over the area, to institute prompt treatment to minimize the further development. These patients must be turned and position changed constantly - every two hours, if on a regular bed, more often

if they are resting on a litter or canvas cot. Rubber rings, doughnuts or thick padding should be placed over the bony areas to minimize undue pressure from those parts. In transporting these patients, Stryker frames should be part of the equipment of the hospital ships and planes used, as they greatly facilitate the care and treatment of the patient, as well as aid in the prevention of decubiti. The body, especially the lower back, hips and perineum should be thoroughly cleansed each day. Especial care should be given the lower back and perineum following bowel movements. In cases of urinary incontinency, it is necessary to change dressings several times daily and cleanse the skin to prevent maceration and burning from the urine. Suprurubic and indwelling urethral catheters should be examined frequently, to ascertain whether they are functioning properly, and thus prevent leakage of urine around the catheter on to the skin and dressings.

Once the ulcer has formed, it spreads rapidly, due to secondary infection, and prompt and vigorous treatment is necessary. Upon admission to the ward, cultures are at once taken of the decubitus to determine the type of organism present. The ulcer is thoroughly cleansed with green soap and peroxide, then saline solution. Debridement of the necrotic tissue of the ulcer is performed. As much as possible of the necrotic tissue is removed, and the epithelium overhanging the sides of the ulcer is trimmed away to expose any undermining of the sides of the ulcer. So long as sloughing tissue is present, a proteolytic antiseptic is used and debridement continued daily. In the presence of active inflammation, daily gauze dressings moistened with penicillin (250 units per cc) are used. Thereafter, simple fine mesh gauze or silk dressings impregnated with xeroform ointment are applied daily, after first dusting the granulations with plasma-penicillin powder (100,000 units penicillin per 2 grams plasma). The ulcer is isolated from gross contamination of the perineum with a sheet of rubberized silk and adhesive. In the presence of susceptible organisms, penicillin, 200,000 units daily is given a few days prior to operation when the ulcer is deemed ready for surgical closure. In severe cases, the patient is placed upon a Stryker frame during treatment of the decubitus, and allowed on his back one-half hour out of every four. This is done to prevent further pressure and necrosis.

Most of these patients, upon admission, present the appearance of marked emaciation and malnutrition, and a large percentage of them have complications, such as genito-urinary infections, pyelonephritis, draining chest wounds, empyema, atelactasis, abdominal wounds, fractures, etc. It is therefore necessary to begin at once to build up their nutritional status and blood level. They are given a high caloric, high protein diet, and supplementary vitamins orally and parenterally. Blood, plasma, and amino acid infusions are used freely if indicated. Additional protein is administered by way of a special formula which is given in addition to regular meals. Once the blood level and nitrogen balance are brought up to, and kept within normal limits, the patient clinically shows improvement in strength and general well being, gain in weight and healing of the decubitus. Such a patient is well on the way to surgical closure of his decubitus.

PREVENTION AND DRESSINGS

1ST LT. DUDLEY F. GRANT, MC, England General Hospital:

We have found that decubiti or "pressure sores" are the most common complication of spinal cord injuries. In our effort to prevent this complication, we have employed the following measures:

1. Keep the bed dry, clean, and as nearly as possible without wrinkles.
2. Keep the patient's skin dry and free from contamination at all times.
3. Change the patient's position in bed every two hours during the day, and every three hours during the night. (An overhead bar or lift is a useful adjunct in that it helps the patient turn himself.)
 - a. Lift the patient, but avoid dragging him.
 - b. If the skin over a point of pressure becomes red, swollen, indurated, or in any way suspicious, this site is to be avoided in subsequent changes of position, if circumstances permit.
4. Daily bath with soap and water, thorough drying, then hardening by gentle massaging with alcohol, especially over points of pressure. After the skin is thoroughly dried, dusting powder (stearate of zinc, etc.) is applied.
5. To pressure points, especially in patients with spasms which prevent utilization of all the various changes of position, we employ massed A.B.D. pads over the sacrum, which we extend laterally to protect the trochanters, and maintain by use of a scultetus binder. (For thin patients, this dressing can be further extended laterally to protect the iliac crests.) The inner aspects of the knees and the heels are protected by snug bandages.
6. No hot water bottles in contact with skin over areas of loss of sensation. .
7. Discourage wheel-chair privileges of over three hour duration without relief of pressure points.
8. Snuggly fitting walking braces with spread of pressure over the pressure points.
9. Bed cradle to relieve weight of bed linen if these are productive of spasms.
10. We feel that mattresses which tend to spread the pressure points will also be of value, though we do not

as yet have any of the more recent types at our disposal. Air or water beds have been recommended in the past, but with the advent of the newer light sponge-like mattresses, perhaps we have a more effective and convenient adjunct.

11. Maintain nutrition.

Faithful adherence to this routine necessarily requires sufficient personnel. Upon occasion in the past, due to circumstances beyond our control, our staff was temporarily depleted with consequent abbreviation of this routine. This resulted in an "outbreak" of small decubiti among several patients.

As for the active treatment of decubiti once they are formed, we have run the gamut of a large number of different topical applications. Each ulcer must necessarily be treated individually, but the following outline of treatment has evolved as the most successful in our experience in treating the average case.

GENERAL TREATMENT

1. Maintain nutrition and serum proteins.
 - a. High protein, high carbohydrate, high vitamin diet.
 - b. Total blood (serum) protein with Albumin-Globulin ration every week if indicated.
 - c. Proteins maintained by supplementary proteins in diet, with resort to gastric intubation or parenteral proteins only if diet not tolerated, and nutrition and blood chemistry indicated need for such measures.
 - d. Parenteral ascorbic acid, 75 mgm every day.
2. Keep patient off of involved area as much as possible.
 - a. We employ an Operative Turning Fram (Stryker) in large sacral ulcers to facilitate turning and relieving pressure at site of decubitus.

LOCAL TREATMENT

1. Culture the wound, if infected, and determine the penicillin sensitivity of the infecting bacteria; if facilities are available.
2. Debride all dead tissue - be as conservative as possible with skin debridement, but try to remove all infected subcutaneous fat tissue.
3. If the ulcer is superficial, it is cleansed with

hydrogen peroxide, lightly sprinkled with granulated sugar, and penicillin jelly dressing applied. Repeated four times a day.

(Penicillin jelly: 35,000 u. per ounce of equal parts of hellow petrolatum and emulsion base. We prefer lubricating jelly as a base when available.)

4. If the ulcer is deep with overlying skin edges:
 - a. Ulcer is first irrigated with azochloramide, with careful protection of the skin by vaseline gauze. The azochloramide is drained off.
 - b. One half to one inch sterile gauze saturated with penicillin jelly is introduced loosely into the undermined or pocketed area, so as to act as a drain, rather than a foreign body. The "packing" is gradually reduced with reduction of wound discharge and appearance of clean granulating tissue.
 - c. Dressing applied.
 - d. Dressings are changed four times a day and oftener if indicated.
5. In cases in which there is evidence of deeper infection, we believe parenteral penicillin to be of value.
6. Although we have not had access to streptomycin as yet, we believe that this drug will be a definite adjunct in the treatment of infection with gram negative bacteria.

This method of treatment has been the most successful for us in preparing the majority of cases for early surgical repair or healing by secondary intention in cases of smaller ulcers, and has facilitated the maintenance of the patients' serum protein, general nutrition, and morale.

THE SURGICAL MANAGEMENT OF DECUBITUS ULCER

MAJOR EDMUND J. CROCE, MC, Halloran General Hospital

INTRODUCTION:

To prepare our paraplegics for the ambitious program of ambulation already described, it is desirable that the large decubitus ulcers, and especially the sacral ones, be healed in the shortest possible time, and the end result be sufficiently stable to withstand

as much trauma as the unbroken paraplegic skin.

The conservative approach to the treatment of decubitus ulcer, by allowing spontaneous healing, has been found to be entirely too slow and the end result unsatisfactory. Split thickness grafts, while expeditious, produce a result only slightly more stable than that of secondary healing.

In May 1945, shortly after the problem was thrust upon us by the return of paraplegics in number from the war fronts, we conceived the idea of raising full thickness flaps from the skin adjacent to the ulcer and rotating them to fill the defect. We have usually planned these flaps in such a way that no corresponding defect was left to be grafted. Thus far this method has been more uniformly successful in the treatment of sacral, rather than trochanteric decubitus, since atrophy of the glutei usually leaves an abundance of loose skin to be borrowed from the buttocks. We are currently working on a somewhat similar method for the closure of trochanteric decubitus, which presents a much more difficult problem because of the tightness of the adjacent skin, the undermining from extensive sloughing of fascia, the protrusion of the surface of the trochanter, and the difficulty in immobilization.

Criteria for Operation

Captain Fitzpatrick has already outlined the methods for the prevention and preoperative preparation of the decubitus ulcer. Our criteria of operability are almost entirely clinical. First, we insist that the patient be completely recovered from spinal shock, in the broad sense of the term. Second, he must have been in a distinctly positive nitrogen balance for several weeks, manifested clinically by an improvement in strength and general well being, a definite gain in weight, and local signs of healing. Third, the ulcer must not present signs of acute inflammation, its floor must be covered with healthy granulation tissue free from sloughing fascia, and its margins must be fixed and invaded by vigorously growing epithelium. In the absence of clinical signs of inflammation, the bacterial flora have been largely disregarded except for the presence of streptococcus hemolyticus and staphylococcus aureus.

Occurrence

Of 109 paraplegics now patients at Halloran General Hospital, 83 have had one or more decubitus ulcers. Of these, 65 have had sacral, 29 trochanteric, and 19 ulcers of other bony prominences.

Operative Procedures

Sacral ulcers (65)

Of the 34 operative procedures for the closure of sacral

ulcers, 30 were done at Halloran General Hospital and four elsewhere. Of these 30, 25 were single stage primary closures by rotating full thickness flaps of skin from adjacent areas, 2 were two stage closures, 1 was a closure by combined full thickness flaps supplemented by small split thickness grafts, and two were closures by split grafts only. Approximately one half of the ulcers measured 10 cm. or more, in the transverse and 8 cm. or more in the longitudinal diameter. Our largest measured 24 x 11 cm. The defect remaining to be covered after excision of the peripheral scar tissue is usually larger by 2 or more centimeters.

At operation, most of the patients require no anesthesia. The ulcer is completely excised, including both the peripheral rim of the scar tissue and the granulation tissue base. If the ulcer is sufficiently narrow in its transverse diameter, that is, less than 7-8 cm., it may be successfully closed by raising lateral flaps from the surface of the gluteal fascia and approximating them in the midline. Triangular wedges of skin may be removed from the upper angle and from either side of the lower angle in order to preserve the contour of the buttocks and the lumbosacral area. If, as is usually the case, the transverse diameter is greater than the longitudinal a diamond shaped excision of the ulcer is made, and curvilinear incisions are made from the inferior angle downward and laterally into each buttock, and from the superior angle upward and outward into each lumbar region. The four sector flaps thus outlined are raised from the surface of the gluteal fascia, rotated centripetally, and this approximated to cover the defect. Fine silk technic has been used throughout.

If the ulcer is shield shaped, with unilateral or bilateral extensions upward to include the posterior superior spine, the skin flaps on one or both sides may be unequal in size.

Trochanteric Ulcers (29)

Of the 12 operative procedures for the closure of trochanteric ulcers, 10 were done at Halloran General Hospital, and 2 elsewhere. The smaller ones were closed by linear approximation after subsection of adjacent skin. Slightly larger ulcers were closed by sliding a skin flap from the buttock. The larger ulcers have presented a difficult problem, and we have currently turned to the use of pedicle flaps from the lumbar region or the corresponding lower abdominal quadrant.

Other ulcers (19)

Ulcers over other bony prominences have been infrequent and small, and have usually been allowed to heal spontaneously.

Post-Operative Treatment

Post-operatively we have used a pressure dressing, employing mechanics waste or foam rubber under an ace bandage applied about the lower trunk in case of a sacral ulcer, or a figure eight

bandage incorporating the corresponding thigh as well, for trochanteric ulcers. If indicated by the presence in the preoperative culture of sensitive organisms, penicillin is administered for 4 or 5 days after operation. After operation the patient is placed in a Stryker frame, four hours in the prone, one half hour in the supine position. Unless otherwise indicated, the dressing is not disturbed for five days, when alternate sutures are removed. The remaining sutures are removed within the next five days. Meanwhile the preoperative caloric and vitamin regime is continued. Within a month the patient is receiving the same care as the patient without decubitus ulcer. He now alternates between the supine and prone position every two hours, is returned to the regular Army bed, and is allowed to sit up in a wheel chair for increasing periods of time.

Complications

Complications following primary closure of sacral decubitus have been infrequent and on the whole, minor. In only one case was the complication serious enough to threaten a successful result. This was an area of ischemia, 7 cm. in diameter, which began 16 days after the closure of an ulcer measuring 12.5 x 10 cm. This complication began after the patient had remained seated in his wheel chair for 6 hours continuously. Even the unbroken paraplegic skin may not withstand so much pressure over a bony prominence. One other patient developed a small area of ischemia shortly after the primary closure of an ulcer which preoperatively measured 14 cm. in diameter. This area was subsequently covered with a split thickness graft. One patient developed a hematoma which was evacuated surgically. Three patients developed small serous collections which were aspirated.

The operative procedures for closure of the trochanteric ulcers were complicated by partial separation of skin margins in 3 cases, and small serous collections in two cases. We have not been satisfied with our procedures for the closure of trochanteric ulcers for the reasons already stated and are contemplating the use of the pedicle flap, a more complicated and prolonged procedure, for the solution of this problem.

We are convinced from our experience that the use of full thickness skin flaps in the closure of decubitus ulcers produces end results superior to those of previous methods. We have observed the scar of secondary healing and the split thickness graft applied over bony prominences ulcerate repeatedly from unavoidable trauma. Consequently we have used the split thickness graft but rarely, for example, to cover small residual defects after incomplete plastic closure of large ulcers earlier in our experience, to cover a small area of post-operative ischemia already mentioned and to cover a large sacral ulcer in a spastic paraplegic who could not be turned on his abdomen.

One might logically ask why we have not operated on all 65

sacral and 29 trochanteric ulcers. Those that were not operated upon had either not reached the criteria for operability or had passed them after admission to this hospital. We do not believe that the results of our procedure are so superior as to warrant excision of an almost completely healed scar or of a split thickness graft.

DISCUSSION:

CAPTAIN JAMES C. WHITE, M.C., U. S. Naval Hospital, St. Albans, N.Y.

Since November 1944 we have closed 13 ulcers. We used the technique just described and have obtained complete healing, usually within two weeks. One ulcer broke down and required $2\frac{1}{2}$ months to heal. We have one patient at St. Albans with a sacral ulcer, 24 x 16 cms, which we hope to close next week. We believe we have the answer to the trochanteric ulcer. It requires a large flap. We have had consistent first intention healing and have not been deterred by streptococcus, staphylococcus aureus, or even by osteomyelitis of coccyx or sacro-coccygeal joint. Successful operative closure does not prevent formation of new bed sores. Our plastic surgeon, Captain Hamm, of Atlanta, is a great help.

COLONEL CUTLER:

At Cushing General Hospital, the principles which are in effect at present in the treatment of pressure ulcerations are:

1. Prevention by frequent passive turning when necessary and by active moving about in bed or wheel chair. Much of this must be accomplished by the patient himself. The patient must be kept dry of urine at all times.
2. Prevention and control of infections by daily dressings, cleaning up the wound with soap and/or boric solution; cautious use of sulfanilamide powder in dirty wounds; vaseline gauze dressings in others; bulky outer dressings in all cases.
3. Early closure by debridement and shifting of large undermined skin flaps, leaving new defects when necessary over adjacent areas which do not overlie bony prominences, these defects to be closed secondarily by suture or skin grafting.
4. It is felt that the use of topical applications to pressure ulcerations is of little or no value and should deserve scant attention.
5. Skin grafting of a pressure area itself should be used only when it is impossible to transpose full thickness flaps.

The results in 124 pressure ulcerations in 65 patients are

COLONEL CUTLER, MC (continued)

as follows:

1. Number closed successfully by suture - 21
2. Number closed successfully by skin graft - 3
3. Number healed by conservative measures, without operation - 57. (Many of these will require excision of the scar and closure)
4. Number remaining open - 43
5. Number of partial paraplegia patients who have not had pressure ulcerations at any time - 18
6. Number of complete paraplegia patients who have not had pressure ulcerations at any time - 3

1ST LT. LESLIE W. FREEMAN, Mayo General Hospital, showed colored lantern slides of decubitus ulcers with their repair.

RECESS FOR LUNCHEON

Halloran General Hospital

AFTERNOON SESSION

PRESIDING: MAJOR BENJAMIN B. WHITCOMB, MC
Chief, Neurosurgical Section, Halloran General Hospital

MAJOR WHITCOMB:

Because of the number of speakers, it will be necessary to start the program immediately. We hope that you will feel free to go about the wards and see the paraplegic patients, if you so desire. Officers will be on hand to conduct you. A resume of all cases has been prepared and copies are available at this desk. When a directive was received from the Surgeon General, placing the definitive care of the paraplegics in Army, rather than Veterans' Facility, hospitals, it mentioned that a medical officer should be placed in charge of the paraplegia ward who had a great deal of enthusiasm for this type of case. We were fortunate in having assigned Lt. Col. Shearer, Chief of Urology Section, who has this attribute. He will speak on "The Ideal Physical Plant".

WARD PROBLEMS AND MANAGEMENT

(3 papers)

THE IDEAL PHYSICAL PLANT

LT. COLONEL THOMAS P. SHEARER, MC, Halloran General Hospital

In the treatment of spinal cord injuries, the physical set-up should be arranged to facilitate ambulation, final stages of rehabilitation and coordination of the many services, both professional and technical, which are required. A central office for the coordinator should be established. The medical administrative officer should set up his administrative program in this office. A stenographer is necessary and a public address system should be furnished with the microphone in this office. It is not feasible to gather together in one group a large number of paraplegia patients and in order to keep up the closest personal contact with the ward officer and the coordinator, a public address system is necessary. Over this public address system announcements and suggestions are made. The patients are encouraged constantly by a series of explanatory talks which are designed to give them insight into their condition. This should not seek to replace personal contact with the patient but should augment it.

The patients are best handled in large open wards with plenty of space for ambulation, wheel chair traffic, and the large number of personnel required in the care of these patients. The beds should be at least 5 feet apart, have good mattresses and be equipped with a Bradford frame and a trapeze by which the patient can move himself about in the bed. Exercise equipment should be available for use by patients who are confined in bed. This may consist of grippers, pulley and weights, springs and other forms of equipment used in developing the muscles of the upper extremities. A large number of bed screens should be available so that a number of patients may be isolated at one time for examination and treatment.

A mechanical device for lifting a completely paralyzed patient from the bed and maintaining him while the bed is removed and changed is a necessary item. Each patient should be equipped with a sturdy chair and a bedside table which contains shelves and drawers. Some type of box or foot locker should be maintained for the patient's personal belongings - this usually fits quite well beneath the bed. Space should be allowed for storage of other equipment, such as braces and crutches.

Special attention should be given to the latrines that service these patients. Some form of fixture should be installed in the toilet by which the patient may lift himself from wheel chair to the toilet without assistance. The shower baths should be equipped with strong chairs, which are firmly anchored to the floor and which contain arms by which the patient can transfer himself from the wheel chair to the bath stool. Benches have proven unsatisfactory because many of these patients are unable to maintain balance without braces unless a back and arms are attached to the chair. At least one bathtub should be installed in one of the bathrooms for teaching purposes. Each of these patients should be taught to transfer himself from the wheel chair to the bathtub without assistance. The entrance of the latrine should remain open in order that the patient can come in on crutches or a wheel chair. In order to maintain privacy, a large screen should be placed in front of the entrance to the latrine. Special holders and bottles used in tidal and other types of drainage should be maintained on the ward and should be so constructed that they can be used with Bradford frames.

In order to bring the work program to the patients and allow them to indulge in occupational therapy and other educational pursuits, special over-bed tables are desirable. These tables should be sturdy enough to hold a typewriter or any type of portable work. Special bedside lights are desirable. Reading devices, some of which project the lettering upon the ceiling, are helpful for the quadriplegia cases. Some sort of device should be used for the prevention of foot drop. Ordinarily this can be a homemade affair, which fits itself to the hospital bed and maintains the ankle at a 90 degree angle. For recreation, a central radio with individual earphones for each bed is helpful in supporting morale. A portable x-ray should be available on the ward at all times. Adequate numbers of well equipped dressing carriages are a necessity and space should be allowed for them to remain on the ward. Large waste cans with tight-fitting covers are necessary for the disposal of soiled and infected dressings. Supplies for catheterization and instruments for dressings should be autoclaved in individual packages and maintained on the dressing carriages. There should be a wheel chair by each bed and a sufficient number of wheel litters should be maintained in order to transport the bed patients when necessary. Some sort of wheel chair fixation is necessary, often a homemade affair can be carried with the wheel chair which satisfactorily fixes the wheel and acts as a brake. Drugs and other equipment should be maintained such as are usually found on a surgical ward in a general hospital.

The large open ward should communicate directly with a large gymnasium which should contain enough space to allow all of the patients to engage in some activity at one time in this hall. The gymnasium should be equipped with various mats. One large mat, preferably 40 by 40 feet, supported on benches about 2 feet from the floor, is desirable. The purpose of supporting this mat from the floor is to improve the psychology of the patient, to make it easier to transfer from wheel chair to mat; and to lessen the work of the teachers who are exercising the patient. A number of small mats should be maintained and used upon the floor for teaching purposes to show a patient how to get from his wheel chair to the floor. Stall bars are necessary and should be installed against an upright, flat surface such as a wall. This is useful when the patient first begins to stand, helping him to assume his balance. A small mat is useful at the foot of the stall bars for employing counter-traction for the relief of the adductor spasms in spastic cases. Long and short parallel bars of different heights should be maintained as they are useful in the early stages of walking and for subsequent practicing exercises. A number of chairs of different types and stability are needed for educational purposes. Low steps, high steps, a bus step and inclined plane are valuable in teaching the patient to cross streets and get up on curbing. Various types of flooring should be used in this gymnasium, such as linoleum, concrete, wood and terrazzo. This is valuable in teaching a patient how to employ his crutches in the various conditions he is apt to meet in after life. Various equipment used in competitive sports are quite necessary, such as basketball, medicine ball, punching bags, indoor baseball and other equipment of a similar nature. If possible this gymnasium should be accessible to the outside by means of a ramp. Outside exercise is important. Basketball equipment can be set up as well as volley ball and baseball. A sun deck should be maintained and an outdoor swimming pool is a desirable part of the equipment. While many will not do well in a pool, the great majority enjoy it much and receive untold benefit.

A special physiotherapy center should be maintained nearby and be accessible to all of the patients. An indoor heated swimming pool is extremely desirable. Massage tables should be available with heat lamps and Hubbard tubs. Equipment for muscle stimulation is necessary and interrupted galvanic stimulation is often required. A number of good walkers, both plane and ramp type, should be maintained. As these patients progress, educational facilities should be established.

A number of small private rooms should be available for individual teaching and for study and practice. Shops should be established for group work in the manual skills, such as wood shop, machine shop, printing, photography, radio repair, dental mechanics, watching and other projects as needed. Music and art should be encouraged as a means of emotional outlet with these patients. In order to have a successful program in music and art, private teaching rooms are necessary. Professional consultation facilities are quite important. A separate office should be maintained for the

LT. COLONEL THOMAS P. SHEARER, MC (continued)

ward surgeon in which various examining equipment should be maintained as in the ordinary ward office. A special examining room should be available for consultation and more specialized examination. A quiet, comfortable room with good furniture in it should be kept for the use of the psychiatrist. To secure all of these ideal conditions, in most cases a separate plant would have to be constructed. It is felt that the expense could be easily justified by increased efficiency in the management of these patients.

The maintenance of personnel in the treatment of these patients creates a serious problem. The number of personnel necessary of course varies with the state of rehabilitation of these patients. Bed patients in general should require about three nurses, four ward men, one physiotherapist, one occupational therapist, one technician for the development of upper extremities for each ten patients. The wheel chair and ambulatory patients should require about three nurses, eight ward men, ten ambulation instructors per thirty patients. These figures are based upon a 24 hour period. One ward surgeon should attend not more than thirty of these patients. A large consultation staff should be maintained and should include the following sections: Neurosurgery, Urology, General Surgery, Chest Surgery, Orthopedics and brace makers, Nutrition, Internal Medicine, Neurology, Psychiatry, Laboratory Service, X-Ray, Eye, Ear, Nose and Throat and Dermatology. On the teaching staff there would be necessary in an ideal set-up about ten specialists in general education, needed to adequately staff manual training shops that have power-driven equipment. Six shop teachers and two occupational therapy teachers are desirable. At least one dental mechanic, one art teacher and one or two music teachers are desirable. The metal crafts and additional phases of occupational therapy should be staffed according to the needs of the patients.

MAJOR WHITCOMB:

We have come to appreciate more and more the powers of observation and ingenuity of Capt. Kuhn of England General Hospital. He will tell us about the ward management of the paraplegic patients.

WARD MANAGEMENT AND DETAILED CARE

CAPTAIN WILLIAM G. KUHN, Jr., MC

The problems incident to the ward management and detailed care of the paraplegic patient may be divided into two categories - Administrative and Professional.

I. ADMINISTRATIVE:

The paraplegic ward at England General Hospital is situated

CAPTAIN WILLIAM G. KUHN, Jr., MC (Continued)

on the 7th Floor of a civilian hotel. The basic structure of the hotel and its rooms has remained unchanged. There are between 3 and 5 patients quartered in each room. There are 38 rooms containing patients, plus nurses' and doctors' offices and treatment room.

The rear section of the 7th Floor has been equipped to house a Reconditioning and Education Section, Occupational Therapy shops, recreation lounges - including a pool room, ping-pong room, and card room; and a walking ramp, curbing and steps for ambulation.

This ward is a direct opposite to the open type found in most Army cantonment type hospitals. It has presented many administrative difficulties. Chief among them is the large number of personnel necessary to maintain the ward. We have 41 Corpsmen on the day shift. One of these men is a Wardmaster, one a linen dispatcher, four are used for irrigating the bladders, and maintain tidal drainage equipment, and the remaining 35 men are used as ward men for the patient' rooms. We have approximately one corpsman for each patient room. The night shift is comprised of one Wardmaster and 15 corpsmen.

The duties of the day corpsmen are extremely arduous. They consist of serving breakfast to the patients in their beds; giving enemas to each patient every three days (Some patients manage to perform their toilets in the bathroom in each room.); cleaning the rooms; turning patient every two hours in the daytime; and assisting some of the patients into wheel chairs.

The corpsman who is assigned to serve the paraplegic patients must be of high quality in character and ability. He must be sympathetic and yet not an easy mark for the patient's whims. We have had much difficulty along these lines for two reasons. First, Medical Corpsmen with an MOS number of 409 have been hard to obtain. We have had to take returnee Infantrymen, Ordnance and Engineer Corps men, and train them in the routine used on the ward. Recently, because of the demobilization of the Army, we have lost almost every man assigned to us within 10 days to 3 weeks after his entry to the Paraplegic Ward. Our second main problem with the corpsmen is the lack of promotions. Because of the nature of their work, these corpsmen work harder than any other corpsmen in the hospital. Their persistence is amazing in view of the fact that promotions are slow or non-existent. We have been unable to help the morale of the enlisted men in this respect because of the over-crowding of the Table of Organization.

The reputation of the Paraplegic Ward quickly spreads among the Medical Detachment and the better men will neither apply nor stick to the Ward if assigned there. If we are to continue to give these patients the best care that is available to them, we must consider our enlisted personnel. The morale of the corpsmen is directly reflected into the morale of the patient, because an

CAPTAIN WILLIAM G. KUHN, Jr., MC (continued)

unhappy corpsman will not do his job to the best of his ability and, therefore, the patient will be found lacking in some phase of his treatment.

In an attempt to maintain morale of the enlisted personnel, I have held monthly meetings with them and discussed all complaints from patients and nurses and myself with them. Their problems were presented to me at each of these monthly meetings and their ideas on how to solve them were thrashed out. In many instances the corpsman was right. There have been instances when the corpsmen complained about supervising nurses being too officious and certain patients too demanding. After discussing these individual problems with the nurses and patients concerned, some degree of harmony was created. However, this has always been short lived. Due to the ever-changing personnel, the same ward man is not put with the same patient or nurse, and the old problem is raised again.

At these monthly meetings, the failure of promotions was explained to the men and copies of letters to their Commanding Officers shown and the replies received were given to them to show that every effort was being made to advance them in grade. However, after 10 months of this explaining to corpsmen, with no concrete evidence of promotions, morale has continued at a low ebb. At times it was necessary to threaten court-martial to various returnee Sergeants for failing to obey orders of Pfc Wardmasters. Wardmasters were chosen not for their rank, but for their ability in leading men and carrying out doctors' and nurses' orders. In summary, a great deal of our problem with paraplegic patients could be solved if we had adequate help, well trained and well rewarded for their skills.

The night shift of corpsmen has varied from 9 to 11 men for 35 rooms. The job of the night corpsmen is not as hard as that of the day shift. They are only required to turn the patient every three hours, give occasional enemas during their 12 hour tour of duty in the night and to help with night nourishment. Complaints from the night men have been relatively minimal. Their only complaint is that of lack of promotion.

We have 31 Army Nurses on the floor during the day hours, and 3 on the night shift. The nurses in the day time are assigned to individual rooms and for the most part the turnover has been low. Nurses are assigned to a room and if cooperation between the nurse and patient is evident, she is left in that room as long as she is a member of the Paraplegic Section. This nurse will do all dressings of decubiti with the idea in mind that because of her highly professional training, she will see the progression or regression in bed sores and take a personal interest in the patient's problem. Problems with the nursing personnel are nonexistent except for individual peculiarities and, if obnoxious

enough, a transfer of this particular nurse is requested.

There are two medical officers on the ward at all times. These two medical officers have complete control of all patients and work in perfect coordination with each other. There are two urologists, who make frequent rounds of every patient, and matters requiring urological care that are picked up on the daily rounds of the two ward officers, are transmitted to these urologists.

The location of the hospital in a city of 65,000 population on a five-mile long Boardwalk, with its connecting, pre-war constructed ramps to side streets, has aided directly in the morale, rehabilitation and ambulation of the paraplegic patient at this hospital. Patients have made unsolicited statements that the location of this hospital within a large city has helped them get over their self-consciousness over their injury and feeling of helplessness. Patients who have been transferred from other hospitals always comment on the fact that they now feel closer to a civilian than they have ever been since their injury. Most Army general hospitals are located about five miles from the main business districts and any civilian contact is greatly lacking. Also adequate facilities are not available for housing relatives for long visits.

Patients attend local theaters, visit restaurants and shops in town and on the Boardwalk, and spend pleasant afternoons with their families on the pavilion and beach reserved for the patients at England General Hospital. Wheelchair passes are permanent and extend from 1300 to 2400.

The ward being a closed type, has brought up the question of advantages and disadvantages of an open and closed ward. The advantages of a closed ward similar to the one at England General Hospital are:

First of all, some form of privacy for the patient, so that he does not feel classified as a group, but rather an individual. After the first 10 months following his injury, the closed ward has the same advantages as an open ward in regard to progress and competitive spirit, because by that time the patient has circulated among other rooms, has been on the walking ramp in competition with his fellow patients and has been attending classes in typing, languages, music, business, and reconditioning at the extreme end of the floor.

The disadvantages of a closed ward are:

First of all it promotes selfishness in the patient and tends to make him less independent than other patients would be in an open ward. In the first 10 months of his injury, I believe an open ward is conducive to competitive spirit and encouragement through observing the progress of his neighbors.

The ideal situation would be a happy combination of these two types of wards. A ward broken up into semi-private rooms containing 10 to 12 patients per room would require less personnel; would give the patient an opportunity for observation of his fellows; would tend to make him more independent and less selfish and a victim of his whims; and still afford a degree of privacy. As the patient progresses towards recovery and shows good psychological adjustment, he could be transferred to a small room containing three or four patients.

II. PROFESSIONAL PROBLEMS:

The medical ward officer in charge of a paraplegic floor must be one who wants to work there regardless of tangible rewards received. He must get his sole satisfaction from the gratitude expressed by the patients. Having grown up with this ward since last January, when we had 38 patients, to our present total of 124, I believe that one medical officer per 50 patients is minimal. Three hours are required for ward rounds. There should be one urologist per 50 patients, who is constantly on the floor and knows the patients' urological conditions as well as the ward officer knows the patients' other problems, ---medical, surgical, and psychological.

There should be good liaison between the ward officer and the various services of the hospital. Consultations should be answered quickly and in the presence of the Ward Officer, so that the patient, if he feels hesitant to ask questions at the time of the consultation, may question the ward officer later on in his rounds.

Morale is best maintained by daily rounds, at which each and every patient is seen and all questions answered directly. If the question cannot be answered, a promise should be made to find the answer or someone who can solve the patient's problem. Frequent evening rounds will impress the patient with the sincerity of purpose of the Ward Officer and reassure him that if he should ever become seriously ill, he would not be neglected. Frequent trips to local theaters, baseball parks and parties, in which the whole group is included, helps cement friendships of these patients.

The general health of the patients has been maintained by early ambulation and daily activities outdoors. By far the greatest adjunct we have for maintaining health is blood transfusion. Blood counts and total proteins are taken routinely every four weeks on every patient. Those falling below normal protein levels of 6 - 8 grams percent, or hemoglobin below 30 percent are immediately given transfusions and blood counts and total protein repeated weekly until normal for two weeks. Food must be high in protein content, at least 130 grams daily, and served in an appetizing manner. For some time we had difficulty in getting the patients to take an

CAPTAIN WILLIAM G. KUHN, Jr., MC (continued)

adequate protein diet. Their chief complaint was the lack of good cooking and the coldness of the meals on arrival at the bedside. We solved this by employing a cook and a dietitian to devote their exclusive time to this ward. The meals were made hot by setting up trays with the cold portion of the meal already prepared, that is the milk, bread, salads, etc., already on the tray, and then an electrically heated food cart was brought to the bed side of each patient and his portion from the piping hot food cart put on his plate and served to him immediately. In addition, we have constructed five dining rooms on the floor at one end of the ward, so that wheel chair patients might eat sitting in their wheel-chairs. Sixty to eighty patients have eaten better since the advent of this method and enjoy the chance to gossip and chat with their comrades.

MAJOR WHITCOMB:

When it comes to the fine details of care and treatment we know that it is the nurse who carries them out. Lt. Ruden will tell us the special nursing problems which she finds among the paraplegics.

NURSING PROBLEMS AND CARE OF THE PARAPLEGIC

1ST LT. CLARA L. RUDEN, ANC, Halloran General Hospital

The care of paraplegic patients, in large groups, rather than as isolated cases, has resulted in a new and challenging nursing specialty. This recently developed field requires a basic foundation, using all the principles of good nursing, plus a thorough knowledge of the particular requirements of combined neurosurgical and urologic cases and the ability to adapt this nursing care to the mental and physical requirements of each individual case.

The nurse should know the background of each patient under her care, which will enable her to understand the reason why he reacts as he does to changing situations. A closer nurse-patient relationship is developed, which promotes a better mutual understanding of the importance of what is being accomplished by nursing care and treatment. Insight into the patient's mental picture is as important to his physical progress as the rehabilitation of his body.

The difficulties in developing and maintaining the entire paraplegia nursing program have been overcome and simplified, largely because of the intense interest in these patients, shown by the Commanding General and chiefs of the various services co-

operating in this project. Only nurses who join in this spirit are being carefully chosen and assigned to the paraplegia section.

The new nurse should be gradually oriented to this type of work, and to the personalities of individuals under her care. She should not be thrown into a ward without being familiar with the problems about to confront her. If she does not adjust successfully, within a short period of time, or, if she finds the work depressing at any time, she should be given the privilege of transferring to another department. Rotation of nurses is necessary to obtain a group that enjoys and takes pride in this type of nursing, and who can create a harmonious atmosphere. Although there is the necessity for care of patients with varying degrees of physical disability, most of the nurses' time is spent with the more acutely ill. All personnel must constantly bear in mind the principle of ambulation and development of self-reliance in these patients. The patient himself should do as much as possible, and the amount of self-care must increase as the patient progresses physically, until he is entirely self-reliant. Care of the combined neurosurgical and urological problems demand practically every phase of nursing technique, and each must be employed to its limit.

Particularly is the nursing care necessary in the problem of decubitus. Cleanliness, special and frequent skin care, (especially over bony prominences), and frequent changes of position, are important. Close observation, and the protection of weak points, are vital factors in routine ward care. Through the use of rubber rings, sponge rubber pads, cotton doughnuts and mechanics' waste, damage to these pressure areas is avoided. At Halloran General Hospital, most of our patients arrive with pre-existing bed sores. After the routine intensive treatment employed to close these areas, the nurse must continue preventive treatment and observation until the patient is ambulant, since there is always a predisposition towards further decubitus development. A regular schedule for frequent turning of the patients has been found effective. The patient's knowledge of the underlying principles for the prevention of decubitus is essential to the successful execution of this program. He is taught that the presence of open wounds retards his general physical progress, making it impossible to get up in wheelchairs or on the mats for exercise and ambulation. In early stages, he helps in turning himself by means of a trapeze on a Balkan frame, and soon learns to perform this task entirely by himself, without the use of the trapeze.

A similar method is used in developing self-reliance in the care of the bladder. The ward men perform bladder irrigations, changing of catheters and catheterizations during the early phases of treatment. Subsequently, patients are taught to catheterize themselves. This depends on their ability to learn the main-

tenance of aseptic technique. Procedures must be closely supervised to insure that they attempt to void completely before catheterization, and that they constantly use aseptic technique. Emphasis should be placed on the care and sterilization of equipment. The patient is also taught, and supervised in, recording his fluid intake and output. In this instruction of the patient, the nurse can get his complete cooperation when he is given a thorough understanding of the results desired.

The nurse also assumes a close interest in maintaining the nutrition of her patients, among whom there are frequent "feeding problems". A cooperating dietitian plans all of the meals, and the individual patients are given some, but not complete, choice of food served. It again rests upon the nursing staff to see that the food which is served is hot, appetizing, and that each patient eats a sufficient amount. Appetites of these patients are none too sharp, and to encourage them, specially desired foods are obtained whenever possible. Most of these patients are on special diets, high in proteins, calories and vitamins, and many are given special, high protein formulae between meals. In extreme nutritional problems, gavage is employed, using the amogens and other formulae. Ambulatory and wheelchair patients are required to take their meals in the mess hall.

Closely related to maintaining the well-being of the paraplegia patient is bowel management. There is never an excuse for impaction. Occasional mild laxatives are necessary, and an enema is given every 3rd day. The importance of proper enema technique must be taught to the ward men. They should be impressed that the enema must be given slowly and retained until the entire amount of fluid is given. Complete evacuation is important because of the total absence of muscle-tone in the lower abdomen and the flaccidity of the bowel. Chair patients are taught to maintain latrine habits. Control is achieved by development of the conditioned bowel reflex. It has been suggested that the use of glycerine suppositories, ten minutes before defecation, would be extremely helpful.

Other types of nursing responsibilities, which should be mentioned, are the maintenance and supervision of tidal drainage and bladder irrigation apparatus, the use of Stryker frames, and the careful adjustment of foot boards on the beds.

In this discussion of the attention given to soldiers with spinal cord injuries, mention has been made of the important features in nursing technique. However, one of the most vital functions of the nurse is that of maintaining the morale of her patient. She must always be an optimist. She encourages him in his educational and occupational training program. She should make the patient feel that he is not going to be a life-long, bed-ridden invalid; but that all the phases of his treatment are pointed

1ST LT. CLARA L. RUDEN, ANC (Continued)

towards progressively increasing ambulation, with constant progress toward becoming an independent, useful, and self-sufficient citizen.

DISCUSSION

MAJOR WHITCOMB:

The topic of ward problems and ward management is now open for discussion. I realize that set-ups in various paraplegic centers are quite different. Those who are working in converted hotels where the large open wards are not available, where the treatment and personnel required are quite different, have other problems than in the Army hospitals with large open wards.

LT. COLONEL FRANK H. MAYFIELD, MC,

Chief, Neurosurgical Section, Percy Jones Hospital Center

I would like to supplement Capt. Kuhn's remarks in regard to ratings given to workers, - enlisted men and WAC's. We have not been able to obtain at our hospital anything like the number of medical officers and ward personnel mentioned. If any action could be started regarding promotion, it would be of great assistance in maintaining interest in the ward.

COLONEL CUTLER:

From our experience at Cushing General Hospital, it seems probable that adequate bowel control can be established in practically all cases (when the patient can be gotten out of bed) by having each patient go to the latrine and sit on a special toilet at a regular time each day. The special toilet is on wheels and is rolled over the regular toilet; enemata can be given when necessary without moving the patient off this special toilet. A trapeze bar is provided over and in front of the regular toilet. Seventy of the patients now use the latrine for bowel movement and sixteen still have bowel movements in bed routinely.

CAPTAIN KUHN:

I would like to mention a difficulty Colonel Mayfield just brought up. He mentioned WAC's. We have only two WAC's. Patients at our hospital prefer male attendants, particularly because a male attendant can lift a patient and take care of the tidal drainage. Our four men, trained in the Urology Section, maintain the tidal drainage and equipment. I would like to repeat that proximity to a large city in which the main streets are easily reached is a big factor. Also in the use of wheelchairs, - if they have no place to go, they won't use them unless they have new sights to see every day, and especially in Atlantic City, in summer the sights are unending.

LT. COLONEL SHEARER:

It is our experience that the same personnel should be maintained. The patients are going to be here quite a while. They get used to the same people handling them all the time and good strong personalities around these men will make them more active in their rehabilitation. Now we have employed every means that we could think of to do with less personnel, but it has finally come to the point where we have to have personnel. It seems that we are losing all the time instead of gaining personnel. Some sort of program should be introduced whereby we could go out and get civilian personnel that we can train and keep for some time. It will be at least a year before we can get most of these people to their own homes. Their stay in the hospital will be prolonged without having sufficient number of teachers, nurses, and professionally skilled personnel.

MAJOR WHITCOMB:

If there is no further discussion, we will go on to the various problems of nutrition which we feel has played such an important part in the recovery of these patients.

THE PROBLEM OF NUTRITION
IN THE TREATMENT OF THE PROLONGED HOSPITALIZED PATIENT

COLONEL GEORGE G. DUNCAN, MC, Medical Consultant, Second Service Command

My remarks will deal with a subject the scientific understanding of which is gaining rapidly on the one hand while the general clinical application of this knowledge lags far behind on the other. I speak of the maintenance of the nutritional equilibrium of chronically ill patients. Far back in history students of medicine were taught according to ritual to bleed, sweat, purge and starve their patients. Prior to the 20th century there was little else, in an active way, that they could do. The modern era has relegated one of these pernicious practises - bleeding - to its proper place. The efforts to relieve physical illness and mental distress by purging are still widely practised. Rooted in archaic and primitive beliefs rather than in physiology and pathology this evil hangs on. However, the far reaching effect which purgation has in disturbing the water balance particularly in surgical and acutely ill and dehydrated patients is receiving increasing consideration. Shortly this practice should follow that of bleeding down the avenue of relative disuse. It is on its way. No so much progress has been made with starvation. The custom of prescribing starvation as a therapeutic measure in the treatment for acute febrile and surgical illnesses is still widespread. In the more learned circles starvation is not prescribed but is permitted. The results are much the same though the dignity of the procedure has suffered.

There are nearly two score of identified substances which the human organism must extract from his environment and take into itself if it is to function properly or survive. Lusk ably defined starvation as "the deprivation of an organism of any or all of the elements necessary to its nutrition". Deficient intake of any of the necessary food components represents undernutrition. A patient may be overweight and yet be undernourished in respect to certain food factors.

The nutritional status of an individual can only be summed up accurately by co-relating the exact intake of the various food factors with the chemical analysis of the body fluids, notably the blood, and the quantitative analysis of the excreta be it urine, feces, vomitus or discharge of exudates or serous fluids. In the past, the body weight has been the indicator of the state of the nutrition of an individual. The body weight is a reliable index in this respect in the normal individual ingesting a normal diet and partaking of normal activities. It is not a reliable index of the state of nutrition of the bed-fast, chronically ill or injured patient. In fact, changes of body weight may be grossly misleading. The undernourished patient with hypo-albuminemia may gain in weight from increasing fluid retention while his state of nutrition is deteriorating. Also, the same patient may enjoy his first improvement with a loss of body weight and fluid. Alterations in weight of from 6 to 10 pounds may ensue as the results of shifts in water balance and be quite undetectable to the eye.

In the first stage of undernutrition there is an indiscernible tissue depletion occurring when an amount of the nutritive factor sufficient to meet the organism's needs fails to reach the internal environment of the individual. At some stage in this depletion not enough of the nutritive factors is present to carry on normal biochemical processes in which they are involved and there develops a biochemical lesion detectable by biochemical analyses. Finally the depletion, progressing unchecked, accounts for the third phase which is that of the anatomical lesion - for example, the swelling of recent intestinal anastomoses, dermatitis, glossitis, cheilosis and possibly the decubitus ulcer.

Mulholland and Co Tui attribute decubitus ulcers to local pressure, and, to tissues impaired in vitality as a result of protein deficiency. In 35 random cases of bed sores they found the plasma protein concentration to be invariably below the lower borders of normal. This represents a tissue depletion of great magnitude. In well controlled studies of eight cases there was improvement in the general condition, gain in body weight, a rise in plasma protein and healing of the ulcers when the nitrogen balance was reversed from a negative to positive balance.

The anatomic lesions of undernutrition are depicted in the skin, eyes, oral cavity, nervous system, skeletal structure according to the respective deficiencies. These combined lesions - tissue depletion, the biochemical and the anatomical lesions are all present in the advanced nutritional disorders. The stage was set for this abnormal clinical state with the onset of the predisposing illness or injury. The paraplegic, the bed-fast and the convalescent patients are susceptible subjects. They are most likely to develop disturbances in nutrition and subsequent complications unless their plight is understood and this understanding is acted upon promptly and continuously until the need for special consideration no longer exists.

The nutritional disturbance may never develop to the stage where gross anatomic changes occur and yet it is probable that wound healing, resistance to infection and the feeling of well being are interfered with. Clinicians too often have their sights set on anatomical changes as indications of deficiencies. This is a late stage and is the result of prolonged deficiencies. Much of our knowledge about disturbance of nutrition is based on total withdrawal of food factors from animals and little attention, until very recently, has been given to relative deficiencies over long periods.

If normal nutrition is to be maintained attention must be focused on what the patient actually ingests and to acquaint ourselves with what it adds up to in terms of nutritional components. I am sure I need not remind you that it is somewhat of a research problem in itself to find out what patients actually eat. I am not referring to the desperately ill but rather to the chronically ill patient - the paraplegic for example. The diet in treating the acutely ill patient with hepatitis became a matter of life and death and we were forced

to have the meals and any left-overs weighed before sufficient attention was attracted to the imperative need of adequate intake. The same is true of chronically ill patients. The difference between the weight of food given to the patient and the weight of the food left uneaten should be checked when circumstances predispose to undernutrition. It is significant how frequently and how far these patients are off the nutritional beam. In short episodes this may be of little moment but in the paraplegic and in the patient with wound healing going on this subject assumes great importance. It is important not to overlook the nutritional background upon which the disorder has flourished or upon which a predisposition to further complications hangs. I know of no therapeutically effective measure which is more often disregarded than that of maintaining a positive nutritional balance during the course of chronic and acute illnesses. We, as clinicians are guilty in this respect and I have an idea that the sins of the surgeons are no less scarlet in this matter.

Protein requirement deserves special consideration. If the energy expenditure exceeds the caloric intake the body protein is sacrificed and what is usually considered an adequate protein intake is not sufficient to prevent a deficit developing. Protein metabolism is spared by a high caloric intake and protein deficits can rarely be made up for more than short periods by giving large amounts of protein unless the total caloric intake is sufficient to prevent loss of tissue mass. Failure of absorption of food from one cause or another or increased demands as in pregnancy, lactation, wound healing, rapid growth and disease magnify potentialities for nutritional deficiencies. Barr and his co-workers at Cornell have observed that a negative protein balance ensued when presumably normal conscientious objectors were confined to bed. The increased loss of nitrogen was most marked after the fifth day. Also there was a marked increase in the excretion of calcium and the pH of the urine tended to swing toward alkalinity enhancing the likelihood of calculi formation.

In civilian life the patient is discharged from hospitals when the acute phase of the illness is over. In most cases this is fortunate as they can have their individual wishes concerning diet catered to at home. This means that in all but the exceptional case adequate caloric intake will be provided. This is, without doubt, the most important aspect of diet in general. Adequate caloric intake not only spares protein metabolism, it prevents abnormal demands on special food factors, notably vitamins, and it is much more likely to afford adequate intake of vitamins and minerals than is a low caloric intake.

The period of hospitalization for the Army patient covers not only the acute illness but convalescent which sometimes is prolonged indefinitely as in the case of the paraplegic. Unless special interest and effort provides an answer to the individual's wishes regarding food these patients, and patients from boarding houses and institutions, are more likely to become undernourished in one or another aspect than are patients discharged to their homes.

A patient seen four weeks ago, a paraplegic, had been admitted to one of our hospitals in January 1945. He was well developed and appeared well nourished at that time but had decubitus ulcers of the heel, scrotum and knees. His blood count on admission was normal but subsequent counts revealed a gradual development of a hypochromic microcytic anemia. The total protein content of the plasma was normal with a satisfactory A/G ration when first determined but subsequent determinations revealed a decline in the total protein and especially in the albumin fraction until on 15 September the albumin was 2.8 and the globulin 2.5 making a total protein of 5.3.

Clinically, anorexia became a problem; and as the months went by evidences of an avitaminosis became apparent. In August edema and ascites developed. The hazards attending his condition were being intensified by the loss of protein in the discharge from the decubitus ulcers.

Multiple transfusions of whole blood and two administrations of plasma between 29 of May and 14 of September failed to prevent deterioration of his clinical condition. On the 10th of September a diet estimated to contain P. 140, C. 400, and fat, 70 grams was prescribed. Vitamin therapy was vigorously pushed and liver extract was given. On 24 September when seen by the speaker the patient's appetite had improved, the evidences of avitaminosis had practically disappeared but the outlook was still grave owing to the persistence and degree of the ascites and the extent of the decubitus ulcers. On 25 September 100 grams of concentrated human albumin were given, on the 27th and 29th 75 grams were given, and the protein intake was increased. 300 grams daily was the intake aimed at but only 162, 160, 182, 170 and 108 grams were ingested on successive days. This was accomplished only with every possible consideration being given to this patient's diet. By 29 September all ascites and edema had disappeared and the patient's condition was much improved and he was taking his diet much better.

This case illustrates what can happen to chronically ill patients kept in hospitals over long periods. This patient ran the gamut of undernutrition from indiscernible tissue depletion to anatomical changes which seriously threatened life. He happened to be a paraplegic and so it is appropriate that we should discuss his case at this conference. But, let there be no mistake about it, he illustrates what can happen and what in my opinion is happening in varying degrees to chronically ill medical and surgical patients hospitalized over long periods of time. The ultimate good which can come of the appreciation of these possibilities, the understanding of the underlying metabolic changes and the carrying through of the necessary prophylactic and corrective measures is far reaching. It extends to every medical and surgical ward, and yet, I confess it is probably the most neglected field of promise in medicine. This is understandable. The onset is insidious. Months and weeks lapse before objective evidences of disease are apparent but it is well known that somewhere in this interim the patients become poor surgical risks, a predis-

posed subject for complications which may steal all the attention of the physician unless he is alert to the problem as a whole.

Acute medical and surgical complications are likely to claim the attention of the internist and surgeon and unless planned consideration is given to nutritional aspects changes, more far reaching than is generally realized, occur to the detriment of the patient.

The prescribing of the diet offers no problem to those familiar with food values. I believe that the approximate values in terms of grams of protein, carbohydrate and of total calories should accompany the diet prescription for every patient considered to be a susceptible subject for undernutrition. The diet would not need to be weighed. An approximation of the values would suffice as a guide to the dietitian. Not until this precautionary individualization of the needs of the patient receiving prolonged hospital care is adopted will needless risk to their health be avoided. Recently, I saw two paraplegic patients in the same ward. One, I believed, should have a diet approximating 125 grams of protein, 400 grams carbohydrate and 3500 calories. For the other I recommended 300 grams of protein, 300 grams of carbohydrate and 3500 calories. The first was a well nourished active, healthy appearing soldier having a normal appetite. The second had no appetite and had edema, ascites, protein deficiency and several decubitus ulcers.

SAMPLE DIETS FOR HOSPITALIZED PATIENTS

I. Emaciated patient with hypoalbuminemia, edema, ascites with an indolent or decubitus ulcer -

Diet (Restrict salt temporarily):

Protein 4 Gm per Kg*	: 280 Gm:
Carbohydrate	: 300 Gm:
Calories 50 per Kg	: 3500
Vitamins	

II. Undernourished patient with indolent ulcers (no edema, ascites or hypoalbuminemia) -

Diet:

Protein 2.25 Gm per Kg*	: 192 Gm:
Carbohydrate	: 350 Gm:
Calories 45 per Kg	: 3100

III. Normally nourished active paraplegic patient -

Diet:

Protein 1.75 Gm per Kg*	: 122 Gm:
Carbohydrate	: 400 Gm:
Calories 35 per Kg	: 2450

* Of normal weight (Example 70 Kg)

To see that the patient actually eats the prescribed diet is the crux of this whole problem. The importance which the physician attaches to the necessity of eating will influence the patient greatly. It will influence the dietitian, the nurse and ward attendant and it will improve the patient's nutritional status. Supplementary feedings should make up deficits. One hundred grams of powdered skimmed milk in 200 cc water yields 34 grams protein and 52 grams of carbohydrate. To this concentrated nourishment ice cream, pureed banana, etc., may be added. The quantity of fluid need not be great. Forcing of fluids by mouth is rarely necessary or advisable. Fruit juices are better omitted until they can be taken in addition to the prescribed diet. The same is true of beer. Fluids of low food value because of their bulk have an unfavorable effect on the appetite.

Parenteral Feeding is a temporary and an emergency measure. It may be the only means of providing nourishment for short periods and as a supplementary measure it has great value but its use should be dictated by necessity not by convenience.

The Fluid Volume should be adequate to prevent the volume of urine falling below 1000 cc in febrile patients and the specific gravity should not be above 1020. From 2 to 10 litres, according to the degree of hydration will be needed each 24 hours. When the patient is unable to take any fluid by mouth 3000 cc, or more, given parenterally are indicated.

Salt. From 8 to 10 grams per 24 hours are desirable. More is necessary if vomiting is a feature.

Glucose. 100 grams of glucose are necessary to prevent gross ketosis so that this amount should be considered a minimum but twice this amount, at least, is desirable while no food is taken by mouth. Glucose may be given subcutaneously but if so only in 5% concentrations. A 10% solution may be given intravenously at a rate of 9 cc (150 drops) per minute or a 15% solution at a rate of 6 cc (or 100 drops) per minute. A small needle (22-26) will aid in preventing a venous thrombosis.

The combined administrations of glucose and salt or glucose and protein hydrolysate are permissible if the solutions are given slowly (5 cc per minute).

Protein. Protein may be provided in form of whole blood, plasma, concentrated human albumin, hydrolyzed protein or amino acids. For purposes of nutrition, casein hydrolysate and amino acids are superior to the blood products which function by maintaining blood volume rather than nutritional balance per se. The administration of amino acids or casein hydrolysate equivalent to 100 grams of protein daily during the emergency is desirable. These preparations are usually administered in a 5% solution combined with glucose. The

rate of administration should not exceed 500 cc per hour (8 cc per minute).

Vitamins may be added to the fluids to be given parenterally to the malnourished patient. The daily amounts recommended are: Thiamine 10 Mg.; Riboflavin 5 Mg; Niacin 20 Mg; and Ascorbic Acid 100 Mg. (Solu-B Upjohn 5 cc provides all but the Ascorbic Acid which should be added separately).

Example parenteral nourishments recommended by the National Research Council in Convalescence and Rehabilitation Report #1, 1 February 1944, are as follows:

"1. It is desired to provide a non-febrile patient who is unable to eat or drink, but is not vomiting nor sweating, and who has no large, exposed exuding surface, for one day with water, salt and enough glucose to prevent gross ketosis.

Water	1500 to 2000 cc.
Salt	5 to 8 gm.
Glucose	100 gm.

1000 to 1200 cc. of 10% glucose and 500 to 800 cc. of normal saline will meet these requirements closely enough. The total amount selected should preferably be given in two equal installments.

"2. If there has been a large antecedent deficit of salt as a result of vomiting, sweating, or transudation, the proportions of salt may be increased. For example:

Water	3000 cc.
Salt	27 gm.
Glucose	100 gm.

In this case 100 gm. of glucose or 200 cc. of 50% glucose are added to 3 liters of normal saline and divided into two portions in the same manner.

"3. To meet the requirements for the nutrition of a patient who will be unable to take any food or fluids for some days and therefore should receive a nutrient which will provide an adequate amount of some protein substitute.

Water	3000 cc.
Casein hydrolysate	100 gm.
Glucose	200 gm.
Salt	10 gm.

This will require 2 liters of 5% casein hydrolysate 5% glucose solution, and 1 liter of

10% of glucose solution, a total of 3000 cc. Since the casein hydrolysate is neutralized it will contain 5 grams of salt per liter, or 10 grams in two liters. Other convenient formulae can be devised by which the volume can be kept below 3000 cc. The selected amount of solution should be injected over a period of about four hours or, preferably, in two equal installments of two hours each. If the patient is given transfusions of whole blood or plasma, the amount of casein hydrolysate will be decreased."

There is a challenge in this problem of nutrition, especially in the paraplegic or other patients subjected to prolonged hospital care.

The success which has met the efforts to cope with this problem in Halloran General Hospital is not to be considered lightly. Clinical impressions have been given abundant scientific support. There is no longer refuge in the complacent acceptance as inevitable the disturbances in nutrition which, it is obvious, can now be prevented in all but the exceptional cases.

ROUND TABLE DISCUSSION - PROBLEMS OF NUTRITION

Colonel George G. Duncan, MC

Major Abraham M. Kleinman, MC, Halloran General Hospital

Major Helmuth Sprinz, MC, Halloran General Hospital

COLONEL DUNCAN:

Major Kleinman, in your experience at Halloran General Hospital, what was the incidence of malnutrition among paraplegic patients?

MAJOR KLEINMAN:

Nearly all patients with paraplegia were malnourished on arrival at Halloran General Hospital. Of 82 patients surveyed, the average weight loss since the time of injury was 49.47 lbs. Only two patients had lost less than 20 lbs; 26 patients had lost between 20 and 40 lbs., 31 patients between 40 and 60 lbs., 17 patients between 60 and 80 lbs., and 4 patients over 80 lbs. One patient had lost 100 lbs., and 4 patients over 80 lbs. One patient had lost 100 lbs. and another had lost 102 lbs.

COLONEL DUNCAN:

Maybe Major Sprinz will comment on the special significance of this loss of weight?

MAJOR SPRINZ:

An average weight loss of 50 lbs. incurred in a few weeks' time is almost unheard of in civilian practice, and can only be compared with the weight loss in other very serious war injuries and burns; for instance, in a series of 29 cases of serious orthopedic and abdominal injuries, we observed a weight loss averaging 48.5 lbs., the weight loss ranging from 30 to 71 lbs. Weight loss by itself is a very important, but not entirely reliable criterion of malnutrition. The evaluation of weight loss must be qualified by the knowledge of the fat stores of the patient prior to injury, and the knowledge of the amount of extra-cellular fluid in the patient. Loss of fat tissue does not necessarily mean malnutrition; as a matter of fact it may be beneficial. Loss of muscle and organ protein, on the other hand is one of the most important manifestations of malnutrition. Protein metabolism is linked to water balance and loss of protein leads to an increase of extra-cellular fluid. In the seriously depleted soldiers some of the weight loss is hidden by the increase of extra-cellular fluid. This "hidden edema" may amount to many pounds.

COLONEL DUNCAN:

What manifestations of malnutrition, other than weight loss, were observed in these patients Major Kleinman?

MAJOR KLEINMAN:

Visible nutritional edema was observed in only one case. The skin in most cases had lost turgor, was pale and dry. The muscle tone was greatly diminished. Only an occasional patient disclosed anatomical evidence of vitamin deficiency such as glossitis or cheilosis. No obvious case of beriberi was seen.

COLONEL DUNCAN:

Why were there so few cases of vitamin deficiency among this group of seriously depleted soldiers Major Sprinz?

MAJOR SPRINZ:

Vitamin deficiency diseases are exceedingly rare in the United States Army, and have only been observed by us in repatriated prisoners who were on a starvation diet for a prolonged period of time. Apparently, a much longer time interval is necessary for the clinical appearance of vitamin deficiency than the three months it takes for paraplegic patients to arrive at a hospital in the Zone of the Interior. In addition, we are very vitamin conscious, and vitamin supplements are probably the first ones given.

COLONEL DUNCAN:

Major Kleinman, what do you consider were the factors which contributed to the malnutrition?

MAJOR KLEINMAN:

The nature of the injury, i.e., the injury to the spinal cord resulting in paralysis, often combined with other serious injuries such as chest and abdominal wounds, led to a state of mental depression with aggravation of the already existing anorexia. Abdominal wounds with perforation of the hollow viscera, necessitating one or more

MAJOR KLEINMAN (continued)

operations on the alimentary tract, and residual enteric fistulae, obviously contributed to the malnutrition. Many patients arrived with infected and draining wounds. All of the paraplegic patients had persistent albuminuria, varying from a trace to 2+. Finally, urinary tract infection was universal in this group producing in most cases a low-grade febrile response. Many patients were subject to repeated episodes of chills, septic fever and sweats lasting from a day or two to a week or more. The cause of these bouts was nearly always due to pyelonephritis, although occasionally other causes were present. In summary, the factors contributing to malnutrition were mental depression, type and multiplicity of injuries, decubitus ulcers, persistent albuminuria, and last, but by no means least, infection.

COLONEL DUNCAN:

Is there any particular effect of a spinal cord injury on protein metabolism?

MAJOR SPRINZ:-

Yes. After any type of injury, but particularly after a spinal cord shock or injury, a peculiar phenomenon occurs in well nourished individuals such as these soldiers were at the time of injury. It consists of a precipitous breakdown of a large amount of body protein and excretion of the nitrogenous end products in the urine. It leads to a serious depletion of the body and accounts for the very rapid weight loss following the injury. It is spoken of as "toxic loss" of protein. It varies in magnitude, depending upon the severity of the insult. It is self-limited. It is independent of fever and the basal metabolic rate. The exact mechanism of the toxic loss of protein is still unknown.

COLONEL DUNCAN:

This sudden deprivation of body protein in contrast with the slowly developing avitaminosis deserves emphasis. Maybe at this time Major Kleinman will tell us of the regimen for treatment of malnutrition at Halloran General Hospital.

MAJOR KLEINMAN:

There are two fundamental principles in our treatment. One consists of efforts directed toward the removal or amelioration of the factors causing the malnutrition. The second is the provision of an adequate food intake. Specifically, the intensive program of activity, education and treatment gives these patients a more hopeful outlook for the future and helps considerably in lifting the state of mental depression. They come to realize that much can and is being done for them and are cheered by visible and tangible evidence of progress in themselves and others about them. The grouping of patients in several different wards, according to the degree of progress which they have attained, has proved to be a great morale builder, as patients find themselves being graduated from a ward of lesser activity to a ward of greater activity. With respect to the second principle, that is, the provision of an adequate food intake, the

MAJOR KLEINMAN (continued)

problem is complicated by several factors. First, anorexia is a most prominent feature. Most patients in this group exhibit an aversion to protein foods, in general, and to meat, in particular, thus creating difficulties in providing an adequate protein intake. Most patients express a desire for green and leafy vegetables and salads; but while the desire for these foods is commendable and desirable, the caloric and protein values are, of course, low. To help overcome these difficulties, patients are permitted a choice of one of two main dishes at each meal. The nurses, dietitians, and Red Cross volunteer dietitian's aides cooperate in serving and persuading the patients to consume all the food. A special effort is made to see that the food is served hot, and served attractively. The routine diet of the paraplegic section contains, as served, at least 3000 calories, including 125 gm. of protein. Furthermore, each patient is required to drink an extra quart of milk daily in addition to any milk included in his regular diet. The chief purpose of this extra quart of milk is to provide an additional 35 gm. of protein to make a daily total of 160 gm. Every effort is made to see that the patients actually consume all of the prescribed diet. Sandwiches served at bed-time are a regular part of the diet, and also help to make up for any food which the patients have refused during the day.

COLONEL DUNCAN:

Major Sprinz have you any comment to make on this problem?

MAJOR SPRINZ:

I am in complete agreement with Major Kleinman, and just wish to emphasize that there is a limit to the amount of ordinary foods which a very sick patient can actually chew. We found that this limit is approximately 120 gm. of protein. Most of the patients are able to eat only 80 to 90 gm. of protein of regular foods though an occasional patient is capable of consuming 145 gm. As these patients are in such a great need of protein, a therapy of over-feeding is indicated. The means available to achieve hyperalimentation, particularly protein hyperalimentation, are the protein hydrolysates and amino-acids for intravenous and subcutaneous use, the protein hydrolysates for oral use, and the processed proteins in the form of mild powder, edible casein, and lactalbumin.

COLONEL DUNCAN:

What method did you use in getting high protein diet into these patients?

MAJOR KLEINMAN:

In the first place, that extra quart of milk, which I mentioned before, served as an extra protein ration to bring up the total protein intake. In the more severely depleted patients, instead of the extra quart of milk, a quart or more of one of the milk formulae devised by us with the assistance of Captain Erna G. Lord, H.D., was given. This increased the total protein and caloric values considerably. A patient receiving a quart of formula IIa, (See at end of discussion)

MAJOR KLEINMAN (continued)

for example, consumes approximately 220 gm. of protein; that is, 125 gm. in the diet and 95 gm. in the formula. The formulae are given with, or shortly after, the regular meal, to avoid a diminution in appetite for the next meal.

COLONEL DUNCAN:

What have been the results in feeding patients with protein hydrolysates?

MAJOR SPRINZ:

We have had experience both with the parenteral administration of protein hydrolysates as well as oral administration. We, so far, have used only 2 parenteral solutions, Amigen and Baxter Protein Solution. Both solutions are safe in routine use. In our limited experience, we prefer Baxter Solution, as we had not a single case of a pyrogenic or depressor type reaction, while with Amigen we had several, including a "near fatal" one. Protein solutions are ideal culture media and any organism introduced into the bottle at the start of the infusion, will have sufficiently multiplied at the end of 2 hours to give a reaction. Protein solutions are slightly acid and slightly hypertonic. With care, any thrombosis of the vein may be avoided even if the protein solution is fortified by 5 to 10% glucose by adding 50% glucose to the bottle of protein solution. The disadvantage of parenteral administration of protein is that we are dealing with chronically ill and chronically depleted patients who require a regime of over-feeding over a prolonged period of time. For this reason, the oral feeding is the appropriate route of administration. Protein hydrolysates are highly nutritious protein foods, but are lacking in some of the essential nutrients as minerals, vitamins, and fatty acids. They have a very objectionable taste which is very difficult to disguise, while the milk formulae are palatable, well tolerated by most of the patients, and are complete foods, lacking chiefly Vitamin C.

COLONEL DUNCAN:

In brief, what have been the results from the regimen just outlined?

MAJOR KLEINMAN:

Under this regimen, most patients regained weight, accompanied by a marked improvement in their general condition. Under the regimen of hyperalimentation most patients regained their desire for food. In most instances, in which very high protein intakes were necessary at the beginning, as the nutritional state improved, there was a decreased desire for the extra protein. Wound healing was accelerated and this was particularly noticeable in the healing of those decubitus ulcers which were not extensive enough to require surgery. This regimen of high caloric and high protein feeding increased the patient's resistance to infection. In many instances there was noted a definite relationship between the degree of nutritional improvement and a decrease in the incidence of infection.

SPECIAL FORMULAE.

These formulae consist essentially of milk fortified with powdered milk and egg proteins. When mixed in the proportions outlined below, they are very palatable and digestible. The palatability is increased for each patient by sweetening and flavoring to taste. Thorough beating of the eggs and careful mixing of the ingredients are important factors in producing a smooth, stable, and tasty mixture.

A very few patients developed diarrhea when they were started on formula III A or III B. This was probably caused by the high fat content of these formulae. The diarrhea promptly subsided when formula I A or I B was substituted, and did not recur when after a few days the formula was changed to II A or II B, and then to III A or III B. Accordingly, our policy is to begin with the weaker mixtures and change gradually to the richer mixtures. It will be noted from the analyses of the formulae, that they are nearly perfect foods in themselves, containing nearly all of the essential nutrients.

In most cases one quart of formula plus regular diet will be sufficient. Where it is desired to give still more protein, a high protein diet may be prescribed with or without any increase of quantity of formula.

Ordinarily, the formula need not be changed beyond II A. However, where the formula is the sole or the chief source of nourishment, then a further step up to III A should be made. Patients are to get two quarts or more a day.

If diarrhea develops and it is believed to be due to the formula, change back to I B and increase gradually to I A and then II A.

If digestion is fairly good, one may start with II A or II B instead of I B. The total daily caloric intake should be at least 4000 calories in the very poorly nourished.

In all cases where both ordinary food and formula are prescribed, the latter should be given with or not too long after meals, in order not to decrease patient's appetite for the next meal.

MILK FORMULA *

I-A

FOOD	Gms	:	C	:	P	:	F	:	Cal	:	Ca	:	P	:	Na	:	Cl
Powdered Skimmed Milk $1\frac{1}{4}$ cups	175	:	91	:	61	:	2	:	625	:	2.035	:	1.540	:	.740	:	1.400
Skimmed Milk 1 pint	500	:	25	:	17.5	:	1	:	180	:	.610	:	.480	:	.255	:	.550
Egg Whites-6	150	:	-	:	18.	:	-	:		:		:		:		:	
**		:		:		:		:		:		:		:		:	
Sugar- 1 tbl.	15	:	15	:	-	:	-	:	60	:	-	:	-	:	-	:	-
Total		:	131	:	96.5	:	3	:	935	:	2.698	:	2.041	:	1.250	:	2.183

I-B

FOOD	Gms	:	C	:	P	:	F	:	Cal	:	Ca	:	P	:	Na	:	Cl
Powdered Skimmed Milk $2\frac{2}{3}$ cup	100	:	52.	:	35	:	1	:	355	:	1.180	:	.880	:	.400	:	.800
Skimmed Milk 1 pint	500	:	25	:	17.5	:	1	:	180	:	.610	:	.480	:	.255	:	.550
Egg Whites-6	150	:	-	:	18.	:	-	:	70	:	.023	:	.021	:	.255	:	.235
**		:		:		:		:		:		:		:		:	
Sugar- 1 tbl.	15	:	15	:	-	:	-	:	60	:	-	:	-	:	-	:	-
Total		:	92	:	70.5	:	2	:	665	:	1.813	:	1.381	:	.910	:	1.583

* Figures represent amounts per quart of formula.

Flavoring added to each formula.

** Amount of sugar varied to taste for individual patient.

MILK FORMULA * #

II-A

FOOD	Gms or cc:	C	P	F	Cal	Ca	P	Na	Cl
***	:	:	:	:	:	:	:	:	:
Dryco 1 1/3 cups	185	85	59.	22	775	1.850	1.498	.740	1.480
Skimmed milk 1 pint	500	25	17.5	1	180	.610	.480	.255	.550
Egg Whites-6	150	-	18.	-	70	.023	.021	.255	.233
**	:	:	:	:	:	:	:	:	:
Sugar- 1 tbl.	15	15	-	-	60	-	-	-	-
Total		125	94.5	23	1085	2.483	1.999	1.250	2.263

II-B

FOOD	Gms or cc:	C	P	F	Cal	Ca	P	Na	
***	:	:	:	:	:	:	:	:	:
Dryco 2/3 cup	100	45	32	12	420	1.000	.810	.400	.800
Skimmed milk 1 pint	500	25	17.5	1	180	.610	.480	.255	.550
Egg Whites-5 plus One Yolk	175	-	20.5	6	135	.043	.110	.269	.247
**	:	:	:	:	:	:	:	:	:
Sugar- 1 tbl.	15	15	-	-	60	-	-	-	-
Total		86	70.	19	795	1.653	1.400	.924	1.597

* Figures represent amounts per quart of formula.

Flavoring added to each formula.

** Amount of sugar varied to taste for individual patient.

*** Powdered skimmed milk may be used instead of Dryco. In such formulas, the fat content will be lower but can be compensated for by the addition of cream.

MILK FORMULA *

III-A

FOOD	Gms	C	P	F	Cal	Ca	P	Na	Cl

Dryco 1 cup	150	69	48	18	630	1.500	1.215	.600	1.200
Milk 1 pint	500	25	17.5	20	350	.600	.465	.255	.530
Egg 4	200	-	24	24	310	.136	.448	.280	.212
Van. Ice Cream 1/2 pt.	125	28	5.5	15	270	.188	.150	-	-
**									
Sugar- 1 tbl.	15	15	-	-	60	-	-	-	-
Total		137	95	77	1620	2.424	2.278	1.135	1.942

III-B

FOOD	Gms	C	P	F	Cal	Ca	P	Na	Cl

Dryco 2/3 cup	100	46	32	12	420	1.000	.810	.400	.800
Milk 1 pint	500	25	17.5	20	350	.600	.465	.255	.530
Eggs	3	-	18	18	235	.102	.336	.210	.159
Van. Ice Cream 1/2 pt.	125	28	5.5	15	270	.188	.150	-	-
**									
Sugar- 1 tbl.	15	15	-	-	60	-	-	-	-
Total		114	73	65	1335	1.890	1.761	.865	1.489

* Figures represent amounts per quart of formula.

Flavoring added to each formula.

** Amount of sugar varied to taste for individual patient.

*** Powdered skimmed milk may be used instead of Dryco. In such formulas, the fat content will be lower but can be compensated for by the addition of cream.

COLONEL CUTLER:

Nineteen of the cases at Cushing General Hospital are still underweight. None of them show gross clinical evidence of avitaminosis. Most of them have one or more bed sores; most of them are confined to bed either because of (a) presence of several bed sores, (b) infections of the G-U tract, (c) the fact that their injuries are of recent occurrence. Adequate high protein diets are provided. Vitamins are administered only when indicated by clinical evidence of their need. Plasma or blood transfusions as indicated are given whenever the serum protein level is found to be less than 5.9 mgm %. Five of the patients who are learning to walk with calipers and braces are markedly overweight. These patients meet regularly with one of the dieticians who is teaching them about the foods they must avoid and how to select foods in such a way as to control their weight. No strict diets have been advised as it is felt that the overweight problem must be handled by the patient himself if any permanent results are to be had.

MAJOR WAITCOMB:

We now turn to the important subject of rehabilitation. Colonel Thom will discuss the psychological adjustment. He has become very familiar with the patients in the Second Service Command and his suggestions have been extremely helpful.

PSYCHOLOGICAL READJUSTMENT

COLONEL DOUGLAS A. THOM, MC

Consultant in Neuropsychiatry, Second Service Command

As I embark upon the task of discussing the subject of psychological readjustment as related to the treatment of the paraplegics I am reminded of an old quotation which runs as follows - "Knowledge is proud that it knows so much, wisdom is humble that it knows so little". I am not sure that this quotation is expressed with exactness, but I am sure that I have neither the knowledge nor the wisdom to deal adequately with this subject. Were it not for the fact that I have been so impressed with the untiring efforts, the skill and ingenuity of the medical officers at the Halloran General Hospital and the England General Hospital in the care of these patients and their keen appreciation of the importance of the mental attitude of these patients in effectively carrying out a treatment program, I would have been tempted to find a way out of this difficult assignment, even at the expense of developing a neurosis.

I make no claim to originality in whatever I may say. The approach to the psychological problems was made by interviews with groups of unselected cases by Major Von Salzen at Halloran General Hospital, and Major Vyner at England General Hospital, neuropsychiatrists, and I have personally interviewed patients at both hospitals. An attempt has been made to interpret the observations of the medical officers who are responsible for the care and treatment of these patients and to add impressions gathered by the psychiatrist which appeared to be significant in formulating definite opinions in regard to their psychological adjustment.

The clinical implications of damage to the spinal cord depend entirely upon the location of the injury. In all cases the spinal cord has been severely damaged and the patient has suffered a partial or complete paralysis of one or both lower extremities and disturbance of bladder and bowel, as well as sexual functions. Invariably the symptomatology and incapacity is at its maximum at time of injury and there is a reasonable expectation that the incapacity will not be increased with time. The non-progressiveness of these traumatic injuries as compared with an acute transverse myelitis or chronic degenerative disease such as multiple sclerosis is an important factor which is of fundamental psychological importance. The patient is not likely to be subjected to the widespread emotional swings that occur with the remissions and exacerbations of an active disease process.

In discussing the psychological problems of the paraplegics we can assume that as in any other injury or disease that patients' mental attitude toward the incapacity is of

vital importance and that maximum restoration of health and function depends upon treating the total organisms. Due consideration must always be directed to the extent which the individual's illness or injuries incapacitates or excludes him temporarily from participating in the normal activities of his environment. Time is always a factor in our efforts to adapt to adversity.

The onset of the paraplegic incapacity is violent and sudden. The combat soldier, who up to the moment of his injury had been in the best physical condition due to his fine training and excellent physical care, enjoyed independence. Concurrently with the injury came total dependence - dependence upon others for transport, sustenance and even for the disposal of body excreta. The patient suddenly and unexpectedly was reduced to an infantile state by his dependence upon others. In the patients studied the initial emotional response varied with the onset of the injury. In those in whom consciousness was preserved there was generally depression often with suicidal thoughts. One man said that there was a grenade near him and for a time he thought of using it to blow himself up. Another thought how terribly his parents would feel and he entertained suicidal ideas. In patients in whom unconsciousness accompanied the spinal injury the full comprehension of the disability was delayed and could be integrated more slowly. In these patients also depression was the paramount emotion, one man related how he would cry himself to sleep every night.

Following the initial depression, a feeling of optimism due to an unwillingness to accept the situation arose. In comparison with the amputee who is confronted with the final and definite fact of loss of a limb the paraplegic sees his limbs and is only aware that they do not work. Often he feels pain which he interprets as evidence of returning function. Frequently he is cheered by misguided sympathy into believing that he will eventually make a complete recovery. The inevitability of the situation is not recognized and the patient clings tenaciously to hopes that cannot be fulfilled.

Coincidental with the physical dependence there is an emotional regression to a less mature level. There are outbursts of rage, temper tantrums, excessive irritability, and impotent anger generally brought on by frustration of aims. A patient who was refused a hypodermic sulked and would not get out of bed for his exercises. Another threw his urinal. A third refused to eat. Patients become hypersensitive to the moods of the nurses and ward personnel. Trivial slights or evidences of indifference bring on bitterness, depression and temper displays. Patients become resentful and feel that others are receiving better care. Many are irritated by hearing nurses and corps men talk of getting out of the Army; it makes them feel insecure and gives them a sense of being abandoned. One

patient thought that he could not get sufficient care and attention unless he babied the nurses. Another feared that his uncontrollable temper tantrums would result in an indifference and less attention on the part of the nurses.

Most patients refuse to accept reality. Wishful thinking replaces reason. One hears the expression, "If I knew I were not going to get better I would work harder on my exercises". Inability to plan, to concentrate, to maintain interest are universal. Patients who begin study courses frequently become disinterested and consequently make little progress. Patients fear leaving the protected atmosphere of the hospital. They fear being a burden upon others. They fear that their lack of bladder and bowel control will lead to embarrassment. They fear being stared at, being over-sympathized with. They fear having to earn a living.

The psychological effect of personnel upon the patients as well as the effect of the patients on personnel is a problem worthy of consideration. The extreme physical dependency of these patients coupled with continuous drain upon the emotions of those caring for them taxes the physical endurance and patience of all the personnel. The ratio of nursing personnel should be increased to meet the demands of the situation. Like the care of children, this is primarily a woman's job. Mature, maternalistic types of individuals with a large amount of missionary zeal are essential to success in this field. There is no place for rigid, exacting disciplinary personalities, in the care of these patients. Patients should neither be coddled nor rejected; they should be prepared to meet the world outside of the hospital as it actually exists. Corps men, physical therapists, occupational therapists, should be carefully selected and permanently assigned to their jobs, with due consideration given to the mental and physical demands, and the necessity for extra relief from duty.

The paraplegic patient is confronted with two extremely important psychological hurdles, the element of time and permanency of his incapacity. The time element becomes apparent following his initial operation when he first realizes with disappointment and concern that this much anticipated event about which he entertained vague ill-defined ideas and hopes that it would restore the lost functions of locomotion and elimination, has failed. He may not have expected complete recovery immediately, but certainly improvement. This operation was an event of primary importance, at least it was hoped to be a point of departure from complete invalidism but actually no marked change took place.

The patient now has to find some other peg upon which he can hang his hopes. Time is the most acceptable and by time

is not meant days and weeks, but actually months and years. But here again he not infrequently clings tenaciously to his wishful thinking and convinces himself that time will result in a complete recovery of the lost functions. The necessity of having to live a life of semi-invalidism has perhaps not been presented with the frankness which it deserves. It is not an easy task. Certainly the situation has not been accepted by many patients who have been in hospital many months. The reality of the situation is denied, notwithstanding the evidence with which the patient is daily confronted by his own experience and that of others.

There is the natural normal psychological phenomenon which we call rationalization or self-deception, which is not altogether without value and which is perhaps encouraged by the medical officer who finds it difficult to decide just when and how much each patient should be told about the limitations which his incapacity will impose upon his future social and economic life. How dogmatic the medical officer can be in any given situation presents another problem. I am sure that many times the medical officer has felt he has explained frankly and honestly the patient's situation and emphatically stressed the limitations which the man's injury will impose upon his selection of a future vocation, only to find the patient planning to engage in some occupation wholly incompatible with his handicaps.

The problem of how best to help these patients meet the reality factors associated with a permanent incapacity of a marked degree is not easily solved by any didactic discussion, inasmuch as every patient must be given individual consideration. The time when the patient should be asked to accept the inevitability of his handicap and the extent to which it will be explained to him represent a psychological operation requiring nice judgment and a delicate technique. Certain modifications in approach will be required for each individual patient. Surely no patient should be called upon to increase his burden while he is battling with unhealed bed sores and an acutely infected bladder or being tormented by pain. On the other hand no patient with a severe cord lesion should be allowed to indulge himself in the process of self-deception or to the extent of planning an occupational career that is obviously incompatible with his handicap, as were four patients recently interviewed - one anticipating returning to the barber shop; the second a repair man for telephone switch boards; third, a butcher; and fourth, an entertainer in a night club.

I am not unmindful of the fact that everyone is entitled to a certain amount of day dreaming -- fantasy life, and that the psychological process of rationalization serves a useful purpose in helping us all over intolerable situations at times, but when this indulgence serves as a retreat from

reality and becomes interwoven into the personality make up and prevents us from meeting the reality situation with the frankness required to build up normal healthy compensations for our physical incapacities or emotional disturbances, it is definitely harmful and defeats its purpose.

There is a time when every handicapped individual should be told frankly in so far as it is possible what he has a right to expect from life under the existing conditions - the extent to which he can reasonably plan on regaining partial function of the damaged parts and the extent he may hope to compensate for his incapacity by developing those parts of the body left intact. Then with a frank evaluation of the anticipated improvement and the compensations he can build up, the question arises as to what are the opportunities available for him to participate in normal living on a basis that is compatible with his newly expected assets. Stress should be put on the things he can do rather than on those which his handicap prevents him from doing.

I have a strong feeling that these men would respond well to group counselling if groups were carefully selected. An opportunity is here provided to discuss the problems of the group, rather than the problem of the individual. It takes on a less personal aspect and I am sure would provide an opportunity for a healthy ventilation of anxiety and tension which many of these men find it difficult to express in individual discussions. Such discussions would not only bring before the group a frank presentation of patients' limitations and abilities but here within the group could be presented the vocational opportunities in which a certain number of these patients could be reasonably expected to carry on successfully.

Apathy was one of the characteristic attitudes of these patients reported by the medical officer and which has been brought up in our conferences and which was also expressed by two officer patients who were quite articulate in presenting their observations. Constant pressure is required in order to get them to participate in the prescribed exercises. They apparently find it easier and more to their liking to place reliance in time rather than effort. There are those who simply refuse, others who use relatively unimportant excuses to remain in bed, and those who state "if I knew just what my condition was going to be I would work harder".

Few patients, I am informed, actually seek the opportunities to utilize the available facilities for education and training. This does not mean that they cannot be motivated to carry on and do the job but it does mean that more personnel is required to keep all the activities moving along. It was also surprising to find how little thought had been given to

their future plans. As one patient remarked "I do not know whether I shall recover 100% or only 75%, so why make plans?" Too many patients are settling down to a prolonged hospitalization, dependent upon compensation and family for future security. Adequate well-trained personnel and facilities for training are in part the solution for overcoming this apathetic state.

Certainly opportunities should be provided, not only for counselling, but actual training in suitable vocations. They should be provided with all the facilities for reconditioning with certain modifications as outlined for the amputees in Circular 298. The whole problem of education and training of this group of patients deserves most careful consideration. Its psychological importance cannot be overstressed. Training without opportunities of utilizing the skills acquired would be but an empty gesture and the placement of those successfully trained would call for cooperation with industry. Personally I feel that the response would be immediate and generous.

Sex conflict will constitute one of the major stresses. Not many of these patients experience any libido or sex drive but they are concerned about embarking upon marriage or even continuing a satisfactory marital adjustment under the existing conditions - and their anxiety is, of course, well founded. Wherever a satisfactory marital adjustment has been made prior to service and particularly in those cases where there are children in the family the chances of continuing successfully are, in my opinion, encouraging.

Most of these men, probably 85%, are single, and without sex drive they will not be disposed to embark upon the hazardous experiment of matrimony if they understand fully their sexual limitations. The patients, as well as their prospective partners, should be fully informed as to what they may expect if such a venture is undertaken. There is no aspect of this whole problem where there is a greater need of well trained psychiatrists to bring about a tolerable adjustment.

The lack of information pertaining to the importance of the psychological adjustment aspect of the therapeutic regime of these cases is due to the fact that prior to the casualties of World War II there had been no opportunity for observing and studying any large number of acute traumatic cord lesions. You will recall that these cases fared poorly during World War I. 80% died within the first few weeks as a consequence of bed sores and catheterization. Cushing reported 32 cases of spinal cord damage, 8 of which were inoperable (all of which died). 24 patients were operated with a mortality of 15, or 62.5%. These cases were all cared for in the forward areas.

Due to the improved organization resulting in more rapid and efficient evacuation of the wounded allowing patients to receive treatment under far better conditions than could be provided in the forward areas, with the advantages of knowledge in diagnosis and surgical techniques accrued during the past quarter of a century, and with aid of the sulpha drugs and penicillin, hundreds of men have left the field of combat to receive hospital care who otherwise would have perished, only to be confronted with the colossal task of taking a life shattered to bits and remolding into something that will justify its existence. If these salvaged men are to be something more than a living memorial to the skill of medical officers or animated exhibits bearing witness to the efficiency of the miracle drugs, the task of rehabilitation must be carried on.

After infection has subsided and satisfactory nutritional measures prescribed, techniques and habits relating to the care of bladder and bowels established, every effort should be made to develop compensatory aids for functions lost by the injury by the substitution of increased power and finer coordination in those parts left undamaged. In addition such artificial aids constructed with the greatest mechanical precision should be provided to render additional support. When these essential medical problems have been cared for and the supportive measures are well under way, it is time to direct the attention of the patient toward utilizing his newly acquired health and efficiency for the purpose of developing all the available assets toward making him an independent well adjusted individual, in so far as conditions permit.

I have taken some time in stating the objective which we must accept as a challenge. In preserving the lives of these permanently handicapped individuals we have assumed an obligation to see that their residual incapacities are reduced to a minimum, keeping in mind that their burdens are not to be carried for weeks or months, but for years. Much of the success with which these patients will meet the problem of adjustment to the reality situations of the world without the walls of the hospital will be dependent upon what happens from this point on.

Briefly stated, hundreds of lives have been saved. There now arises the question - for what good purpose. It is our responsibility to supply the answer.

AMERICAN RED CROSS SERVICE

MRS. HELEN N. THIRLWALL, Field Director,
American Red Cross, Halloran General Hospital

The purpose of the hospital program of the American Red Cross is to provide Social Service and Recreation for patients in Military Hospitals. This program is carried on by professionally trained social case workers and recreation workers assisted by volunteer corps such as the Hospital and Recreation Corps and Arts and Skills. My remarks will be limited to the experience of the Red Cross Hospital Service at Halloran General Hospital in relation to the rehabilitation of those patients with spinal cord injuries.

In working with patients with spinal cord injuries the social component in their medical care is obviously of great importance, both in the broad sense, including recreation, and in the specific sense of medical social case work with the individual. By definition, social work is the art of helping a person to help himself. With this focus in mind the social case workers, recreation workers and volunteers who assist in this program, function.

The patients with spinal cord injuries face the usual social problems that the average soldier has, such as - family problems, financial problems, vocational problems, anxiety over illness and the like. With this group, however, they are exaggerated because of the nature of the illness which necessitates basic social and emotional readjustments aggravated by the necessity for long time hospitalization. The most significant problems which this group has to face appear to be the following three: 1) anxiety about the illness itself and its implications; 2) anxiety and a need for readjustment to themselves and new family relationships; 3) an adjustment to a new occupational, professional and recreational life. Bearing in mind these problems the program of social service and recreation is set up.

Perhaps one of the best ways to begin to help the patient with these problems is to help him in utilizing the great amount of leisure time he has. This is valuable for the present situation and as training for the future. In this area the recreation program functions most obviously. In the main there are two types of recreation, the supportive or passive type, and the active participatory type. The massive type includes movies, some type of plays and spectator events for the individual and group. In the active type, where the patient can help himself there are individual and group activities also. The patients on the ward so far have learned to play chess, bridge and how to tie flies for fishing. Some are learning to play the piano or some musical instrument. Some are participating in publishing the ward newspaper by writing and by reporting. Some are interested in collecting stamps or coins. Some have participated in a project to make the ward more attractive by painting furniture. Then too, under the Occupational Therapist's guidance, the Red Cross Arts and Skills volunteers may help him to learn to paint a picture or sketch,

make a leather belt or do wood carving, etc. Perhaps one of the most satisfactory recreational projects which has helped the patients adjust to the community are the trips which are arranged by the recreation staff. Even litter patients are taken off the hospital grounds to picnics, to baseball games or sightseeing trips and to the theatre. This in general, outlines the specific recreational program for these patients.

In relation to the more complex adjustment, to himself, to the family and to new occupational plans, the social case worker may play an important role. In the first place, the social worker makes rounds with the Medical Officers so that she can understand the medical problem and it affords an opportunity for the Medical Officer and her to make joint plans for the good of the patient. Thus the patient accepts the social worker as part of the program of his medical care.

In the supportive role the social worker first of all must listen to the patient's anxieties about his illness. At first this function of support consists mainly in just listening and is of a definite help. At this time too, the fact that the patient with his disability is accepted by the workers and volunteers is valuable at the moment and acts as a preparation to acceptance by the family and the community. However, there comes a point soon where it is necessary for the social worker to help the patient to accept his illness and to face the problems related to it. Throughout, the social worker must anticipate the maximum for the patient, but without his awareness also prepare for the least. Although there are many problems which this type of patient faces which are not directly related to his illness which the social worker helps to solve, I will not discuss these today, but confine the discussion to specific problems which are related to his injury. To meet these needs in addition to general social case work treatment, three concrete projects have been undertaken by the social work department in cooperation and consultation with the Medical Officers.

I. A study of home conditions as well as a social history is obtained on every patient. The social worker through the Home Service in each man's home community determines the family resources both physical and psychological and interprets to the family the patient's condition and his needs so that the family can better understand him when they come to visit and when he goes home on furlough. This alleviates the situation such as happened in one case where a man was glad to return to the hospital after his furlough because his family had made him feel so uncomfortable when he was at home. Also the Medical Officer can better understand a patient when he knows the background from which he came and the setting to which he must return.

II. The second project is related to work problems. In cooperation with Reconditioning, a study was made of a number of patients to determine vocational desires and the relationship with former work experience to future plans and necessity. Of twenty cases so studied there were only three patients who could continue in their former occupation. Thus seventeen must change. Ten of

this group had a positive idea of new interest. Two of the group are already taking courses to help their adjustment to new work. For example, one patient was a truck driver and has decided to try to be a secretary and he has been given a typewriter and is learning to type and take dictation.

III. The third specific project is that of utilizing Red Cross transportation to take men home on weekend passes, so that they may adjust to home conditions gradually. For example, one man was taken all the way by Red Cross ambulance from Halloran to Troy, New York, because his mother had died and it was felt that it would be valuable for him to be home at this time. In this connection the information regarding home conditions is of inestimable value.

We realize that we are just beginning and that there is much to be done qualitatively as well as in learning additional resources for the medical social care of these patients. We feel at this time that the implications of the need and the value of medical social treatment of these patients cannot be underestimated. We present this paper with the sense of humility and realization of the necessity for continued study and work to further help in being of service to this group of patients who are so much in need.

AMERICAN RED CROSS SERVICE

MRS. ANNE B. WILLIAMS, Field Director, England General Hospital
MRS. DOROTHY L. PIERCE, Social Worker, " " "
MISS ELEANOR ROTH, Recreation Worker, " " "

In this brief paper, we have attempted to set forth specific service given the paraplegic patient by the American Red Cross at England General Hospital. Our workers are part of the hospital team, interested and striving at all times to help the patient, and also help him to help himself. Our activities are planned in accordance with recommendations and approval of the doctors and nurses, and it is felt that our role in the paraplegia program rounds out the total effort to make these men's stay here as comfortable and hopeful as possible.

The following sections give a picture of the functions of the social worker and recreation worker on this ward.

Social Service

On daily ward rounds the social worker visits the new patients, offers Red Cross services, welcomes them to the hospital, and offers a free phone call if they have not talked with their family since coming to the states. If the patient is extremely tired after his trip, the contact is brief. If he wants to talk, the worker learns something of his condition, and whether he has told his family the extent of his injuries. For the most part, patients have told their families by the time they reach this hospital. Many of them say it was the Red Cross worker overseas who helped them make the decision and assisted them in writing the letter.

Occasionally a man will ask that his family not be notified that he is here - he does not want to see them until he can walk. Although every effort is made to help him arrive at the point where he can tell his family of his condition, in rare instances the patient has asked to have the Red Cross Home Service worker in his own community talk with his people and prepare them for their visit to the hospital. After discussing this with the medical officer on the ward, a letter or telegram is sent to Home Service, Red Cross Chapter. The family is urged to visit at their earliest opportunity. If they do not have adequate funds, the local Red Cross will assist them. As soon as the patient has decided to let his family know that he is here and to have someone interpret his condition to them, he feels much more relaxed and relieved and is anxious to see them.

When the family arrives at the hospital, prior to going on the ward, the worker gives them a verbal picture of the patient, his attitude toward his injury and to the medical treatment which he is receiving. They are given positive assurance that our medical officers on the paraplegic ward are superior and their approach is sincere and understanding. They are urged to greet the patient affectionately, and to accept him on the same basis as before his injury.

They are also urged to control their emotions and if possible not to shed tears. If the family desires, the worker accompanies them to the patient's room, and remains during the first few moments of their meeting so that they may follow her example of complete acceptance of the patient.

During their stay, an appointment is made for the family with the medical officer in order that they may have an opportunity to learn the patient's diagnosis and prognosis. Very often if they have not been completely aware of the extent of the injuries before talking with the medical officer, it is necessary for the social worker to give assurance and interpretation - to let them talk out their feelings or otherwise release their emotions. For this reason during the first visit at least, arrangements are made for the near relatives to stay in the Red Cross Guest House which adjoins the hospital. Under such a plan they are in close proximity to the social worker at all times and take advantage of the situation by talking with her daily.

One very young blond haired patient had written his mother that he was paralyzed below the waist, but had deliberately not told her that his right leg was amputated above the knee. He wanted to break the bad news to her gradually, he said. His mother, a widow, had been dependent upon him prior to his entrance in the Army, and he thought she was getting a bad "break". He wanted to make it as easy for her as possible. The social worker arranged for the mother to stay in the Guest House, upon her arrival at the hospital. Her son talked with her, about his amputation, during the first visit. The following day she talked with the worker in the office. She was remarkably calm and accepting of the patient's injury. It is unusual to find a patient and a parent equal to handling such a situation so adequately.

The role of the social worker is pointed up in working with the wife of a very attractive, intelligent, thirty-one year old patient. This man is a graduate of a famous law school, and felt perfectly adequate in solving his problems alone. In the first meeting with his wife, a vivacious young woman of twenty-six, he had unfortunately brought out the possibility that their future life together would probably be without any sex satisfaction. The wife came to the social worker almost hysterical. For over two hours, she talked and cried at intervals. She had been reared in a family in which the members were very warm and affectionate in their relationship with each other. She had found her adjustment to her husband difficult even before his injury, because he was reserved and showed little affection toward her. The following day she came to see the social worker more calm but having spent a sleepless night and was not able to eat. She again talked for about two hours; - obviously depressed, she proposed how difficult she was going to find accepting her responsibilities as a wife in this new role. As soon as she was sufficiently calm, an appointment was

made for her with the medical officer. The social worker had previously told him of her reaction and he was very concerned and understanding. He assured her that her husband was expected to improve and that soon he would be up in a wheel chair and later walking with the assistance of braces. He could make no definite statement about return of function of sexual power, but left her not entirely without hope. The next day when she came to the office, she was in a more cheerful hopeful mood. The medical officer had given her encouragement and assurance. It was then that we were able to help her look forward to the future, and to see her responsibility in giving her husband strength, and patient understanding during his long convalescence. We pointed out the fact they already had two attractive children, and this would assist them, in part, to have a normal family life. After she was here about a week, Mrs. Q. came to the office to say goodbye. She expressed much appreciation for the help given by the social worker during the time she was so emotionally disturbed. She was grateful that Red Cross offered case work services to the family as well as the patient. She had been helped to accept her husband's condition almost completely and was able to give him a great deal of support in planning their future life.

Our medical officers urge the patients to get out of bed as soon as possible. When a man gets into a wheel chair, the social worker suggests a trip downstairs, to become acquainted with the facilities of the recreation hall, the visitor's lounge, the office floor, sundeck and the PX. When he becomes strong enough to use his arms, he can go all over the hospital by himself in the wheel chair. This gives him a feeling of independence which he has not enjoyed since he was injured, and of course is a morale builder. The social worker secures patches, ribbons, has their clothing pressed so that as soon as the medical officer permits, the patients are ready to go outdoors. With the exception of a very few, they are eager to explore the Boardwalk. They are encouraged to participate when able in recreational activities in the recreation hall and in the reconditioning program, which includes occupational therapy, physical reconditioning and the educational programs.

When the patient has progressed mentally and physically to the point he can accept his prognosis, the medical officer discusses this with him. It is then that the social worker helps him to plan realistically for the future, whether he will spend the balance of his life in a wheel chair or eventually walk so he can again work and assume the responsibility for himself and family.

The social worker makes an effort to see daily the patients who are in intense pain. If they express any reasonable wish she tries to gratify it. Many of these men take little interest in their food - if any special delicacy is desired, and is not available in the diet kitchen, with the approval of the medical officer it is secured on the outside by the social worker.

Frequently the worker visits these bed patients after the supper hour. Those who are able to be in wheel chairs are usually up and out of their rooms at this time. It is a lonely period in the day for those who must remain abed. They welcome someone who understands their condition and to whom they can talk with perfect freedom.

The medical officers have a wonderful relationship with the patients. The men have complete faith and confidence in their ability and sincerity. They feel free to talk with them about their hopes and their fears and the doctors are always ready to listen. This attitude accounts most of all for the high morale which is found on this ward.

Recreation

To the paraplegic patient who must be bedridden over a long period, whose progress is slow and often accompanied by setbacks, recreation becomes an important factor in his recovery. The recreational activities are many, being active or passive, physical or mental, but with the proper selection on the part of the patient and the recreation worker, these activities should help to fill long, monotonous hours and aid in the ultimate recovery of the patient. With the necessary medical approval, on this service, our program emphasizes meeting individual patient needs; whereas on other services equal stress is placed on group as well as individual planning.

Probably the most popular diversional activity is the movie. Three times a week a current, full-length movie is brought to individual rooms on the floor where bed-patients and wheel chair patients may spend an enjoyable evening. In circulation every day and evening are several electric phonographs. Most boys enjoy the popular records, but a few like an occasional afternoon of classical or semi-classical music. An adequate record supply is on hand at all times.

Bed-patients especially like making records of their own voices and sending them home. We have had many an enjoyable evening making records, some purely in fun, and others in a more serious vein. One patient in particular, an accomplished clarinet player, has done some excellent solo, duet and group recordings. Several times this patient has been invited to play with our England General Band and we hope he will be included as an important member of the all-patient band.

Aside from the field of music there are other hobbies which are of interest to the men:

1. Stamp Collecting has proved its value as a hobby for all and is an activity in which paraplegics take an active part. It helps to occupy time, holds interest and above

all affords contacts with other people - i.e. fellow patient philatelists, and men from "Stamps for Wounded Committee" on their weekly visits.

2. To a patient who never leaves his room and cannot hold a book or light a cigarette for himself, an aquarium with tropical fish that live and multiply, becomes an important part of his everyday world.
3. The Chess Club is a Red Cross activity in which the patients participate. Members of the organization, "Chess for Wounded", visit the hospital daily to teach the men or play a game with them. Several of the paraplegics are able to attend the weekly Chess Club Meetings held in the Lounge, outside the Recreation Hall. Last Spring we had a Chess Fiesta here with many chess champions visiting and playing with the patients.
4. As an adjunct to the Occupational Therapy program, which offers so many functional and diversional activities, we have a Red Cross Arts & Skills program offering ceramics, painting, sketching, and woodcarving. These are quite enthusiastically received by this patient group and those who do well are interested in continuing the hobby.

Some patients prefer being entertained rather than actively participating in something creative. This brings us to another responsibility of the recreation department -- providing live entertainment for bed-patients. What patient wouldn't be a little thrilled at having Myrna Loy, Clifton Fadiman, Miss America, Joe McCarthy or Harry James come to his bedside and talk to him? With such famous people and many less famous but talented entertainers, we bring to each patient the kind of fun and the show he likes best. Perhaps it is watching a magic man as he makes a rabbit appear from a hat, a lovely girl sing his favorite song or listening to a sportsman discuss the recent events in the field of baseball or football or laughing as some comedienne "cracks wise" - and this all means a day when the world outside his hospital room becomes a reality.

It is sort of a homey feeling to know that even if you are hospitalized you can have a birthday or anniversary party and for any such special occasion we try to make these outstanding days as happy as possible. Birthday cakes are ordered four days ahead - the families are told of the plan if they are living in Atlantic City; particular friends of the patients are gathered - plans are cleared with the nurse and dietitian in order that nourishment will be served at the same time as the cake. The recreation worker arranges the cake on a tray with napkins, ice cream, flowers and a special birthday present. Occasionally ward entertainment augments the group singing or group games. As may

be imagined such parties are important events to these celebrants.

As soon as the paraplegic patient is able to travel around the hospital in a wheel chair, the problem of boredom from hospital routine becomes less acute. Then the patient has access to the Red Cross Recreation Hall where variety shows, hostess parties, sport smokers, broadcasts, jam sessions, concerts, teas, etc., help to pass many an afternoon or evening.

We are lucky at England General - the weather is usually good and there is always the five mile stretch of Boardwalk where Gray Ladies on duty day and evening escort our paraplegic patients up and down. There are hundreds of little shops, amusement centers, and spots of interest right on the Wooden Way. During the summer months, the beachfront, equipped with a pavilion, soft comfortable lounging chairs, all done in blue and yellow, was a heavenly spot to relax while sipping a coca-cola and listening to the "England Generals" give forth with their smooth music.

Patients on Stryker frames, and those in wheel chairs, daily were taken down to the sundeck, overlooking the beach, and in midafternoon cool lemonade was served by our Red Cross Canteen. Hats are off to our Gray Ladies who do all the thousand little services such as writing letters, sending packages, shopping, visiting and countless things which add to our patients' comfort and happiness all year round.

Of late we have encouraged as many paraplegic patients as possible to take advantage of our trip program. This past summer we had several patients spend five days at a time, at the "Red Cross Summer Home" in Bridgeton, New Jersey. This ideal country spot, situated on a river, with pleasant surroundings, good fishing and swimming and nourishing home cooked food, proved to be just what the doctor ordered!

Last Spring some of our paraplegic patients frequently attended the Yank's Spring practice games here in Atlantic City. Since autumn has rolled 'round, it is football! On our first trip of the season two wheel chair and two ambulatory patients from the paraplegia ward attended. They loved it - they want to forget about hospital routine just as other patients are able to do and if hearing the crack of a baseball; watching that trick forward pass or chewing a medium rare steak in a swank hotel, can help them do that - - and the ward officer approves - - then we want to make it possible, and more.

Recently we have helped get ready our sections of the reconditioning unit right on the paraplegia floor. There are recreation rooms with comfortable chairs and lounges for visitors, victrola records, a radio, games and ping pong tables. Also there's a music room where men interested in learning how to play wind or

string instruments can receive instructions, and a quiet lounge for nothing more than reading a good book or entertaining the folks from home in a cheerful, home-like atmosphere. We hope in this way that each man will be able to make every day in the hospital count towards something to make it as happy, as full, and as worthwhile as possible.

To summarize, our work with paraplegics aims to:

1. Assist them and their families in making some sort of emotional adjustment.
2. Help to make their hospitalization as comfortable and pleasant as possible, and
3. To provide entertainment and recreation that is enjoyed as well as contributing to the progress of convalescence.

MAJOR WHITCOMB:

In peripheral nerve lesions with which we have become so familiar, and in which group we place some of the cauda equina lesions, we have leaned on physical therapy, particularly in the stages of paralysis. When early function returns, we have found that it is naturally replaced by occupational therapy. The use of those muscles which have just started to return will be definitely speeded up by its use. Occupational therapy has a big role in not only building muscles, but building morale and its part in the paraplegia program cannot be overestimated. Miss Ruth Robinson will discuss "Occupational Therapy".

OCCUPATIONAL THERAPY

MISS RUTH A. ROBINSON, Occupational Therapy Consultant
Reconditioning Division, Second Service Command

Experience in the Army has shown that Occupational Therapy is a definite treatment modality. Occupational Therapy is that form of treatment characterized by assignment to a purposeful task prescribed by a medical officer. It is prescribed for restoration of function, for controlled activity for nervous or mental disorders, for readjustment attending chronic diseases, for reeducation of those patients with permanent disabilities and for purposeful utilization of leisure time. In an Army General Hospital the emphasis in Occupational Therapy is placed on workshop activities and the Arts and Crafts. The success of such a program is directly related to the interest of the responsible medical officers and the occupational therapy staff.

The program planned for a patient who has had an injury to his spinal cord must take into consideration the terrific emotional upheaval he is going through. His natural concern for himself and for his personal problems often results in a loss of confidence which may lead to what appears to be complete indifference. Unless active measures are taken, these attitudes slow his recovery and they certainly will lead to an unfortunate mental state.

The individual who is going through a period of adjustment to a distressing situation finds it easier to adjust if he has a job to do that is interesting and has a definite purpose. Work has a place in the normal day and it is of paramount importance that each patient's day be made as nearly normal as possible. The measurement of a patient's accomplishment must be based on the individual's capacity, mental as well as physical. Occupational Therapy supplies the purposeful activity to meet his need.

When a paraplegic patient is ready to begin his occupational therapy program he is still a bed patient. His interest in any type of activity is poor, his work tolerance is almost nonexistent, but he has a latent desire to do something. Although leather work is not the only activity that a patient may at first show interest in, nor the only activity suitable, in many instances it is his choice for a first effort. A simple leather project, carefully prepared, has all the qualifications for the beginning of constructive activity on the part of the patient.

1. The technique is simple; therefore, the patient learns it quickly which helps to restore his confidence in his abilities.
2. The working period is short leaving no time for discouragement or lag in interest.
3. It is almost foolproof and the project is certain to be brought to a successful completion which helps build his confidence and sustain his interest.
4. The finished article looks almost professional.
5. It makes an attractive gift.

Because of the development of a sense of accomplishment in the patient he is often anxious to continue work on similar articles. However, he must be encouraged to do progressively more difficult projects and to take more responsibility for the planning and execution of his work.

During this period of the patient's hospitalization if the Occupational Therapy approach to him has been wisely planned and diligently carried out a part of each day has been spent in the

MISS RUTH A. ROBINSON (Continued)

constructive use of his available energy along lines that he has found satisfying. This, we have found, has helped to restore his self-confidence, sustain his morale, build up his work tolerance, encourage good work habits and has given him the opportunity to do something purposeful.

When the patient is permitted to use his wheel chair and can come to a shop the opportunities for stimulating his interest and allaying his fears for his future are much wider. The shop should be planned with his physical capacities in view. Work benches should be constructed to permit easy access in a wheel chair; tool cabinets should be arranged to permit the patient to reach every article without difficulty; the hand printing press should be placed at a low level; power tools should be lowered and stabilized; adequate safety precautions should be taken. The activities offered should be as varied as space and ingenuity permit. Those activities which have been most interesting and which have proved the most practical are woodworking, plastics, metalwork, ceramics, printing, photography and the fine arts.

Occupational Therapy is not vocational training and does not pretend to be; but the very nature of the activities used in the treatment program are directed toward crystalizing the patient's thinking along vocational lines and with paraplegic patients this tendency should be utilized to the patient's individual advantage. Let him try one activity after another; eventually, with direction, he will find one that will suit his need. Give him an opportunity to utilize the skills he already has and from there he will begin to think of augmenting these skills for use in the future.

Coincident with participation in Occupational Therapy the patient should be referred to the Educational Reconditioning officer so that the two departments can correlate their efforts in his behalf. If the patient's interests extend beyond the facilities of the Occupational Therapy Shop everything possible should be done to encourage the exploration of his potentialities by the Educational Reconditioning officer. If he is physically able, a job on his ward may be what he needs, or perhaps working in the main Occupational Therapy Shops with new companions and a broadening of his outlook may be what he requires. Each patient is an individual and his work must be planned for him individually; if he has suggestions or plans they should be used because they are a measure of his increasing interest and stimulation of his interests and providing of motive is of primary importance.

The Occupational Therapy personnel working in a program for paraplegic patients must be selected carefully. They should have a psychiatric background, and they should be flexible and adaptable. Before they are assigned to the ward they should be well grounded in the physical and mental background of these patients. If they are to do a good job they must know what they are trying to do and they must

like what they are doing. Volunteers may be used to advantage if they can report regularly, if they can be objective and if they have a definite skill to offer plus a real interest in their work. The personnel assigned to work with these patients should not be changed as these patients prefer to have familiar people around them and they may suffer an emotional set-back which will interfere with their progress if changes are made.

To summarize, the purpose of an Occupational Therapy program for patients with spinal cord injuries is to help them to help themselves adjust to their physical limitation; to afford them an opportunity to explore their potentialities, thereby building their self-confidence and assisting them to make constructive plans for their future.

MAJOR WHITCOMB:

The final paper on rehabilitation takes up the Educational and Shop Program, by Lt. Colonel Shearer.

THE EDUCATIONAL AND SHOP PROGRAM

LT. COLONEL THOMAS P. SHEARER, MC

It soon became apparent that the educational program that proved effective for the other patients was not well adapted to the paraplegics. Many patients signed up for the USAFI Correspondence courses. Within a short period of time they tired of the courses. Not one lesson was sent in, and soon all trace of ever wanting to study disappeared.

A broader and more personalized program was then instituted, when fifty volunteer teachers from the New York City Board of Education agreed to come out and teach the patients. It proved to be a different type of instruction from anything they had done before. These men had to be encouraged and motivated to think again, to mentally grow again. For the past months they had been living solely in a physical world; now they had to be started off again in a mental one. The problem that faced these teachers was, therefore, how to restore interest in their minds and lives. These men were and are, perplexed and confused; they are constantly asking themselves, "What am I going to do when I get out of here?" "I can't go back to my old job with this injury." Our volunteer teachers must put courage and determination in their souls; these patients must be given faith and hope in themselves. The seed that is sown in the patient's mind will germinate and his future depends on the motivation he gets here.

14. COLONEL THOMAS P. SHEARER, LC (Continued)

Generally, the hospitalized soldier is hesitant about what he wants to do; he is receptive to plans based on reason or superficial thinking. He can try his hand at many things at Halloran: photography, printing, radio, auto mechanics, plastics, electricity, watch making, dental mechanics, telephone, wood working, music and the arts. If he does not wish to enter the mechanical, technical or industrial fields, the volunteer teachers will instruct him in Book-keeping, Commercial Law, Economics, English, Mechanical Drawing, Calculus, Algebra, Chemistry, Spanish, Stenography, Typing, English, French, German, History, Physics or other academic areas.

In many cases the subjects are utilized as a subtle means for achieving other ends. English, for instance, is made a medium for re-introducing the patient to the world outside where he will find himself in competition with other men again. Again, the study of mathematics becomes an introduction to the many types of jobs where mathematics is the base and where chair-ridden can operate successfully. In another direction Halloran General Hospital was established as a Regents Center to enable interested patients to obtain their high school diplomas. Last August quite a number of our men took the State Regents examinations and 35 received certificates for the successful completion of a course.

Before the teachers set up their present program, the dulllest period in the ward came after dinner, from 5:00 PM to 7:00 PM. The administration, therefore, set aside this time for the school period. Now the wards present a tremendous change in atmosphere during these hours. Teachers can be seen at the bed sides or groups of 4 and 5 ambulatory patients found gathered around an instructor in some corner of the building. A typing class is conducted in the mess hall, which is also the center of the school, almost every evening.

There is also a Vocational Guidance Council, which was recently organized, the composition of which is unique. Men in various industries are brought in to advise the individual patient. We have experts in advertising, salesmanship, auto mechanics, printing, radio, etc.; wherever there is a call for any other field, an expert is readily secured. One patient has been offered a new job by his old firm. They want him to start training for personnel work. As a new field to him, one of our experts in personnel work is taking charge of this patient, bringing him the necessary books, helping him and guiding him. Another soldier excels in mathematics; he has been encouraged to go into the insurance business. Another patient who shows aptitude for salesmanship is being encouraged to work with a telephone teacher, to learn salesmanship over the telephone. Another man who studied accounting in college, has been working with a teacher and in a short time has done the equivalent of one year's work.

We now plan to have lectures and classes held during the day. We are inviting various industrial leaders to address our patients and tell of the opportunities in their companies and in their field. The Telephone Company is going to give a course on salesmanship over the telephone, and on how to operate a switchboard. The Executive Vice-president of the National Plastics Manufacturers Association gave a lecture with an illustrated technicolor motion picture on the nature and future of work in plastics. We are desirous of getting these organizations interested in these men to the end that they may give them jobs when they are ready for them. We plan to sell, for cash, the work the patients make in the shop, and we feel that all these approaches are only the beginning of our still broader program.

In our music program, the teacher's approach is the main thing. These men are much more shy and reserved than the average patient. The music program was started in June and it was almost impossible to get even one man to try out the keyboard. They would stand around the piano and listen to the teacher play. Soon some of them started to sing when the teacher played a tune they knew, then one mustered up enough courage to confess he might like to play. That started it off. Now there are twelve patients in the group, all of them beginners. Many of the bed patients are learning to play the auto harp because it is so much easier to manage in bed.

We are forming an ensemble of violin, accordion, clarinet and piano. We have found that these patients use music as a social outlet rather than as an emotional one, or as a means of artistic expression. They seem to get more out of it as their numbers increase. They are now working toward a Christmas show. It took one man, who formerly played the violin, three months of coaxing before he would go back to his lessons.. Since he was also interested in violin repairing and has expressed a desire to do that work when he was discharged, we are arranging to interest an instrument repair teacher in teaching him the trade.

The music teacher found working with these patients far more difficult than with the ordinary patient. They seem to be high strung and nervous, but once the contact and confidence are established, their power of concentration is the same, although they tire more easily. The student who has made most musical progress has also made the most physical progress.

The shop is the crux of the training program. Getting the machines set up at the proper height where they could be worked from a wheel chair was found to be unsafe. Therefore, a "sitting bench" was devised to be placed in front of the band saw and the lathes. By means of a horizontal bar extended above the seat, the patient is now able to lift himself from the wheelchair to the bench. The "sitting bench" enables patients to work machines that would be too high for a person other than in a standing position. Along

LT. COLONEL THOMAS P. SHEARER, MC (Continued)

these lines the suggestion was made of shortening the legs of the band saw and the lathes by eight inches for the wheel chair patients; this was found to be impractical and unsafe.

The jig saws were lowered and extended eight inches beyond the bench to enable a man to work in a comfortable position from a wheel chair. He will be able to work as well as an ambulatory patient can from a normal height. Drills were lowered 18 inches from the normal position. The ambulatory men can work it at this height but it will be more comfortable from a sitting position. The hand tools are racked so that all tools may be easily reached from a wheel chair position.

The shop power tools consist of:

1 Band Saw	1 Engine Lathe
1 Jointer	1 Disc Sander
2 Drill Presses (1 Hand)	2 Jig Saws
1 Wood Lathe	1 Double Head Grind Stone

Two work benches were built five feet by ten feet, and three feet by seven feet; to a height sufficient to permit the arms of a wheelchair to fit underneath for a comfortable working position. A vise has been placed on each of the four corners of the benches, or eight vises in all.

There are three machinist vises set about twelve inches below normal working height so that a patient may easily assume a comfortable working position while in his wheelchair.

It was agreed by the teachers that two types of articles could successfully be made in this shop for a rehabilitation vocational training program:

1. Any personal project that a patient may want to make for home; e.g., a play pen for a child, toys, end tables, wall racks, foot stools, etc.
2. Mass production: toy wheelbarrow, overall size 30" long x 12" wide. The operation will call for:

1 Man on lathe to turn wheels
1 Man on bench assembly
1 Man on painting
Etc.

The articles made for production will be marketed for Christmas and sell for \$7.00. Other items that have been suggested have been tables and chairs for children, hobby horses and rockers. There is one shop teacher working full time with ten volunteers to assist during evening.

LT. COLONEL THOMAS P. SHEARER (continued)

Through subconscious motivation presented through these shop experiences, a paraplegic will find he has a definite place in his community, where he will be capable of making a living and becoming a useful member of society.

MAJOR WHITCOMB:

I hope that most of you will have an opportunity to visit the shops before you leave, if you have not already done so.

I would like to ask Colonel Seidenfeld to open the discussion.

DISCUSSION

LT. COLONEL MORTON A. SEIDENFELD, MAC, Chief, Clinical Psychology Branch, Office of The Surgeon General:

I have been impressed, during the entire discussion of this morning and afternoon, with the failure on the part of those who have spoken to pay heed to the tremendous number of psychological problems which the paraplegic patient must face. Great emphasis is placed upon the care with which diagnosis, operative procedures, diet, medication, etc. are given the patient, but little or no heed has been given to the importance of careful, critical and accurate planning for the psychological needs of the patient. This problem is not one bit less in importance than that of the other elements of medical and surgical care. Surely it is unfair to the patient, and to the doctor as well, to imply that teachers, business men and the whole host of non-medical people who come in contact with the patient, are better equipped to decide on the work tolerance, mental capacity, vocational aptitudes, and motivation than is the clinical psychologist who has been specifically trained to work in this area. It has been said that the doctor hardly has time to see his patient because of the variety of activities that are superimposed upon the patient. I think that this is a fair criticism, and I suggest that we correct it by allowing the physician, the psychologist, and the social worker to function as a team to prepare an appropriate plan for the psychological prevocational and vocational readjustment of the patient.

LT. COLONEL CHARLES W. ELKINS, MC

First, I would like to congratulate the staffs of Halloran and England General Hospitals on the excellent program. So much work is going on - so much occupational therapy and physiotherapy, so much medical care. Patients become tired of all these different things. There are times during the day when they would like to do nothing but rest.

I would like to propose my plan for treatment of this type of patient. Let us get them medically well as much as we can. Let us get them into braces, and get them walking, if possible, and then

LT. COLONEL ELKINS (continued)

let us treat them individually. I would like to propose a model set-up for about 1300 paraplegics. These cases can be followed in many ways. I know considerable discussion is going on in the SGO. I know it is going on in the paraplegia centers, 22 or 23 of them. One of these plans is to group these patients into six centers. Many things are in favor of this. One of these is that men could be close to home. There are many things against the proposed plan. One of these is that you will have six personnel difficulties instead of one if they were quartered in one colony. I propose that the Government, or the Veterans' Administration, spend ten million dollars, not to establish a hospital for paraplegics, but to establish a so-called school for paraplegics. They have been well treated in the Army, and had the best scientific care available, for the better part of a year or over a year. Most of them are now ready to step out and be trained in some one activity. Let's not cram these things down these patients. They are going to get tired of it. They know they are in a program now. They are individually interested in it, but they will get tired of all these various activities. I believe that the plan of a single center for paraplegia is the feasible one; one that can be worked out, one that will require centralized personnel, centralized buildings. This program should last five years. At the end of five years we will have gotten out of the 1300 group a certain percentage of successful takes. I don't know what per cent it will be. No one knows what it will be. If one gets 10 per cent of these patients in useful, gainful occupations it will be worth all the time and money spent.

CAPTAIN KUHN:

I have four questions: (1) Pensions for paraplegics. I have 20 patients about to be discharged. They have been home for 60 to 90 days. A few applied to colleges, a few to jobs, a few have no plans. They have come back to me after interviewing the Veterans' Administration representative and have come up to me with the question of braces. They say they want the braces back as it does not pay to get well. A 100% medical recovery is not a 100% recovery to the patient. What will his compensation be? (2) What should be the furlough policy? I have been generous on my furlough policy. Most wire in for extensions and I grant 90 days' extension. (3) Do you tell your patients just what their condition is as regards the spinal cord? I tell them where they stand. I do not tell them on admission, but wait until they have regained some health. I show him a similar case. I tell his wife or a relative of the patient. I have had no sad experiences. Has any one else? A number improve when they know where they stand. (4) Should limbs be amputated? My answer is unalterably "NO" and I would like to have other opinions. Colonel Elkins expressed a good thought as regards cramming too much down the throats of our patients. I have asked some patients what they thought about one central place and they said, "What are we - lepers?" I repeated the question to different types. Those that have the best chances do not want a central place and those who do not have a chance would like one.

MAJOR WHITCOMB:

I tell the patients the condition of their cords. We have told the patients definitely where they stand when we know. Some of our patients are newer to us than at other centers, as we are relatively young. All of us have seen lag in return of function. In one case at Walter Reed, one man was walking 5 months on crutches. He showed no evidence of return, sensory or motor. After reviewing the overseas record, I told him and his family that there was no chance of return of function. Two weeks later, he had sensation in his legs and shortly thereafter he had motion in both lower extremities. It is unusual and I think that in many cases where there is complete cord lesion we can tell the patients where they stand and what they might expect and we do believe in telling them exactly where they stand.

COLONEL CUTLER:

Three patients at Cushing General Hospital had mild depressions, but have improved and are no longer considered as problem cases. No specific measures were necessary. These patients apparently do best when left in their own group and are carried along in all group activities. The one case having a moderately severe reactive depression has shown slight improvement on this same regime. There has been occasional misconduct of decreasing frequency. A grievance committee meets once a week and submits to the section chief a written memorandum of patients' complaints. In turn, cases of misconduct are referred to this committee for disciplinary action. It is felt that in the type of patient in question such self government is the most effective method of control.

One of the wards has been set aside as a work-shop. Here patients will do piece work for certain factories as follows:

Roller skate assembly for Matthews Mfg. Co.
Preparation of parts of radio tubes for Raytheon Mfg. Co.
Braiding of leather for shoes for French, Shriner & Urner.

The patients will be paid by the respective companies for work done. The advantages of this project are obvious.

COLONEL AUGUSTUS THORNDIKE, MC, Chief of Reconditioning Division, SGO:

This subject of rehabilitation of paraplegics is much under discussion in our office now. There are conferences going on with the Veterans' Administration and we are trying to work out the best plan of handling these cases. General DeVoe, you are to be congratulated highly for the program your staff has developed here. There are limits to which we can go. There are 22 centers, some in isolated areas. The same program that you have been able to accomplish here could not be put on everywhere. I think what Col. Elkins said about forcing things down their throats is important. I think there is danger of developing a program in too wide a field when they will be limited in their occupational opportunities. So if you do put on a work program, devote it to those occupations that the men with disabilities can make something of after they are discharged from the service.

20 October 1945
Thomas M. England General Hospital
Atlantic City, New Jersey

MORNING SESSION

PRESIDING: COLONEL JOHN H. LYONS, MC
Chief of Surgical Service, England General Hospital

Opening Remarks

BRIGADIER GENERAL SIDNEY L. CHAPPELL, USA
Commanding, England General Hospital

It is indeed a great pleasure to me to be the host at this this second day of the conference for paraplegics. I saw a great number of the visitors last evening on the train. Those I did not see last night I wish to greet for the first time and those I did see I wish to greet again. I particularly wish to welcome the representatives from the Veterans' Administration, the Navy, the Red Cross, and Dr. Munro, who I believe is the only civilian representative here. For many years I was engaged in the Army in psychiatric work. In those days I used to think about theory, ideals and things of that kind. For the last four or five years I have been doing administrative work in hospitals and for that reason got quite a different angle on this problem. The practical carrying out of any plan is an important one. The purpose of the meeting to-day is the interchange of ideas and the working out of plans to help these individuals. It is remarkable that what has been done in the last year or two has changed our ideas as to what can be done for these patients. The surgeons, neurosurgeons, internists, and G.U. men, and in fact men in any phase of medicine and surgery will be needed to help those men who have had spinal cord injuries. The personnel problem enters into every phase and directive that we have. We have 67 enlisted men on the paraplegic ward, 19 of those are on at night. We have six men or women on the reconditioning program, three janitors on that floor, 13 people working with the messing on the floor. We have a total of 45 nurses and other women, making a grand total of full time people on the ward to take care of that group, 134. We have six others on part time, making a total of 140 to do the work that we want done. We do not have enough enlisted men. We should have 75 or 80 men on that floor. I mention this especially for the reason that one of the visitors is a representative of the Veterans' Administration. Again I wish to express my pleasure and the pleasure of my staff for the opportunity of being here today. We have met again many of our old friends and we have met many new people, who I hope will be old friends after today. I will be glad to help anyone with his personnel problems or any advice I can give you and our whole hospital will be able to render any such survey as you may need.

THE BROADER ASPECTS OF THE PROBLEM

LT. COLONEL JOHN E. SCARFF, MC, formerly Chief, Neurosurgical Section,
England General Hospital

Retention of urine follows invariably all serious injuries of the spinal cord. This problem is acute within a few hours and is present so long as paralysis persists. Cystitis, pyelonephrosis and nephritis and urinary calculi constitute perhaps the greatest threat to the life of the paraplegic patient. The care of the bladder, therefore, is of major concern.

The treatment of the so-called "spinal cord bladder" falls into two categories: - emergency and definitive.

The first principle in the emergency care is to prevent extreme over distension with its attendant fissuring of the bladder mucosa and paralysis of bladder musculature. The early introduction of an indwelling catheter which should not be clamped off at any time, is indicated, especially before any long journey is initiated. Retrograde infection of the bladder urine caused by the catheter will not be serious and can easily be cleared up, provided that the bladder mucosa has not been torn nor the bladder musculature paralyzed by extreme distension.

The definitive care of the bladder - with which we are concerned at this meeting - properly begins with the patient's arrival at the first established hospital which, in the field, would be the evacuation hospital, and it continues so long as the patient is paralyzed.

For years, the only objective sought in the definitive care was avoidance of serious urinary infections with their resultant high morbidity and fatality; and the only treatment was a supra pubic cystostomy. This was in itself highly objectionable, for it allowed the continued drainage of urine into the abdomen and required frequent changes of bulky dressings. Moreover, after such an operation, the bladder could not become distended, and remained in a state of complete collapse. As time went on its walls gradually lost their elasticity - partly from lack of stretching and partly from chronic infection extending in the wall from the bladder cavity which was always infected. After several months in this state, such a bladder could never again serve as a collecting reservoir of urine - even should the patient later recover from the spinal injury. Physical - not to mention social - rehabilitation of such a patient was almost impossible and death was the rule after a few months.

In 1934, a neurosurgeon of Boston, Dr. Donald Munro, whom we are honored to have as our guest today, developed a new method for the care of the bladder which he called "T-D" and which has revolutionized our treatment of this difficult condition. Tidal drainage does not require a suprapubic wound. Instead, a standard indwelling urethral catheter is used, and this is connected to a simple device which alternately distends the bladder to the normal capacity and then empties it - repeatedly, continuously and automatically.

With tidal drainage, it had been found in civil practice before the war, that the bladder could be kept free of any serious sepsis almost indefinitely; and which is of further great importance, the normal bladder capacity and the elasticity and reflex contractility of the muscles of the bladder wall could likewise be maintained. It was then found that many patients who did begin to recover function in their spinal cords 3 to 4 months after injury, were able to resume, once more, voluntary control of bladders and that a large majority of those patients with permanent paralysis were able to establish so-called "automatic bladders" - clinically free of infection. The method was this. After it had been thoroughly established that voluntary control was not going to return, the tidal drainage was discontinued and a system of manual expression of the urine was instituted. At regular intervals firm pressure would be exerted upon the abdominal wall just over the bladder with the two fists of the attendant. This would be maintained until the bladder contracted reflexly - with sufficient power to force the sphincters, and to empty itself. As this was done at periodic intervals of 4-6 hours as time went on, less and less pressure would be necessary to empty the bladder; so that soon the patient himself could do it. Between these voidings, there was no dribbling. The patient was able to choose the time and place of emptying his bladder. He was able to wear regular clothing - visit friends - attend church or theatre - and carry on certain kinds of serious work. In short, a high degree of both physical and social rehabilitation was possible.

In the European Theatre of Operations, those entrusted by the Chief Surgeon to establish medical policy for the care of soldiers with spinal injuries - in the beginning Colonel Loyal Davis, for a time myself, and finally Colonel Spurling set as their goal not only the prevention of immediate serious urinary sepsis, but also the preservation of the anatomical integrity of the bladder for the purpose of ultimate social rehabilitation of the patient along the lines above described.

In the general hospitals and neurosurgical centers of the American Army, located in England, from August, 1942 until "D" day

LT. COLONEL JOHN E. SCARFF, MC (continued)

on June 6, 1944, tidal drainage was established as the method of choice in the treatment of "cord bladders"; and suprapubic cystostomy was strongly discouraged except under very unusual circumstances.

In planning for the invasion of France, tidal drainage was still considered feasible. The planners were well aware, of the difficulties such a system might have met in the African desert or the mountains of Italy - where evacuation of the wounded was often slow and extraordinary difficult. But in Europe, where distances were less and roads much better, it was anticipated that the patients with spinal injuries would be in an evacuation hospital within a relatively few hours after being wounded; and from there, high priority for air evacuation to the well equipped neurosurgical centers in England seemed assured. The directive on the care of spinal injuries published by the Chief Surgeon just prior to the invasion date specified that tidal drainage should be used. During this pre-invasion period, close liaison existed between the Chief Surgeon's Office and that of the surgeon of the 1st Army. At the latter's request, the consultant from the Chief Surgeon's Office met with all of the neurosurgeons attached to the 1st Army, and with the surgical chiefs of the Evacuation Hospitals and the principles and practices of tidal drainage were fully discussed and enthusiastically accepted by that group. The 3rd Army was somewhat similarly - though less thoroughly indoctrinated.

During the actual invasion period and for many months thereafter - the paralyzed patients sent back from France to the neurosurgical centers in England had all been treated by tidal drainage. Then gradually - more and more of the paralyzed patients began to return with suprapubic wounds. This was due to several factors - primarily to the advent of new armies in the theatre - for instance the 7th, the 9th and the 15th. Parts of the 7th Army had fought in the African Desert and in the Italian mountains and their unique experience in these difficult terrains undoubtedly justified their belief that the suprapubic drainage was the only safe method. Others simply had not come under the persuasion of the Chief Surgeon's staff and had evolved their own doctrines, in which the immediate safety of the patient completely obscured the long term objective of his later rehabilitation.

At that time, there was no opportunity for the indoctrination of these new groups on the subject of tidal drainage and with the rapidly lengthening lines of communication and the inevitable confusion of warfare, it was perhaps inevitable that the new and unfamiliar method should have to give way to the older more familiar one.

LT. COLONEL JOHN E. SCARFF, MC . (continued)

At the present time, in the neurosurgical centers in this country, differences in belief and practice still exist in regard to the treatment of the spinal cord bladder. Some believe as I do that this is best accomplished through the use of tidal drainage. Others believe that tidal drainage is of no value. That I think, is the most important issue today in the care of the "cord" bladder. It is time that it be settled.

PHYSIOLOGY AND PATHOLOGY OF THE URINARY SYSTEM
IN THE PARAPLEGIC PATIENT

CAPTAIN ERIC R. SANDERSON, MC, England General Hospital

On admission of the usual paraplegic patient to this hospital, the urologist is presented with a soldier having a spinal cord injury, a suprapubic cystotomy, and a paralyzed bladder. The urologist's aims in treatment, so far as the bladder is concerned, are first to heal the suprapubic cystotomy, and then, eventually, to give the patient a bladder which he can empty per urethra at regular intervals, a bladder with a minimum residual, and a minimum of spilling over between voidings.

During the early stages after admission to the hospital, healing of the suprapubic cystotomy is accomplished by inserting a urethral catheter without tidal drainage. This simple expedient has been effective in healing all but three of our cases, and those three required revision of the cystotomy. It was felt that revision was required because the cystotomy had been done too close to the symphysis rather than to any factor which might be attributed to the paralyzed bladder itself.

After the suprapubic cystotomy has healed, tidal drainage is instituted. This is done to maintain bladder capacity during the period of partial return of bladder function, to keep the bladder actively dilating and contracting, and to minimize bladder infection and the formation of bladder calculi.

We set up the tidal drainage apparatus so that the bladder empties when its contents reach 300 to 400 cc. That amount is selected so that if the patient is to become automatic, he may be able to go on a regime of micturition every four or six or eight hours and still maintain a daily output of approximately 1500 cc of urine.

The incidence of severe bladder infection is cut down, the formation of calculi and the accumulation of mucus are decreased by the frequent interchange of fluid in the bladder as a result of tidal drainage. Solutions used here for irrigation include boric acid, solution M, solution G, and 0.5% acetic acid. The last is preferred since it is effective in dissolving mucus and calcareous matter which collects about catheters to form bladder calculi. Solutions M and G, with the same properties, have the disadvantage of being more irritating and are used little at present.

After a period of tidal drainage, generally about three months after the original injury, the urethral catheter is removed with the result that the bladder is either comparatively normal, or an attempt to establish automatic bladder control must be made. Our aim in establishing automaticity is to produce a "social" bladder, or one which empties at regular intervals with a minimum residual and a minimum of spilling between urinations.

On removal of the catheter, an arbitrary time routine is set up for emptying the bladder, every 4 hours, six hours or eight hours, depending on the convenience of the patient and his impulses to void. At these definite intervals, the Crede maneuver is employed and the patient exerts abdominal pressure in the lying or sitting position to produce voiding. Complete emptying is sought to minimize residual and prevent spilling until time for the next micturition.

If this regime is unsuccessful, or if the residual is high, we also catheterize the patient once daily and instill argyrol into the bladder since cystitis and bladder neck irritation will interfere with the development of satisfactory automaticity.

If, after this, there still is unsatisfactory automaticity, cystoscopy is done to inspect the bladder neck with the possibility of transurethral resection in mind.

The foregoing, then, is our routine treatment used in all cases of cord bladder in the effort to establish satisfactory habits of micturition. It is based on the following theoretical grounds:

Although the physiology of micturition is not understood completely, these conclusions appear to be accurate. Parasympathetic nerve fibers, arising from the second, third and fourth sacral segments, form the pelvic nerves which supply both motor and sensory fibers to the bladder. The pudendal nerve, arising

from the same segments, supplies semivoluntary control to the external sphincter, but its role is not fully understood. Sympathetic fibers probably are of minor importance in bladder control. Bladder contraction results from distension of the viscus, the center of the reflex arc being located in the conus medullaris or the sacral cord. The higher centers are inhibitory in nature.

A transection of the cord above the cauda equina, therefore, blocks off the nervous pathways to the higher centers and leaves the reflex arc intact. After the initial period of shock, this results in the "automatic" bladder in which integrated reflex bladder contraction remains but higher control is lost. The eventual result is a bladder which shows hypertonicity and perhaps hypertrophy of the detrusor muscle, residual urine, and some type of active urinary incontinence, varying from a precipitate type of micturition occurring at long intervals to almost continuous small spurts of urine.

A lesion of the cord in the sacral region may result in destruction of the center for reflex bladder activity. This produces the "autonomous" bladder which has lost both higher control and reflex activity, with the result that frequent ineffective bladder contractions are initiated within the bladder wall itself.

These theories of the mechanism of action of the bladder hold true in cord transections in the experimental animal, but in traumatic lesions in the human, of course, the response to injury is variable due to incompleteness and irregularity of the lesion. From a practical point of view, the autonomous bladder will have more frequent uncorrelated contractions, resulting in more frequent spilling and a higher residual than is the case with the automatic bladder. A cauda equina lesion may also miss the reflex center and higher cord, and still produce incontinence as the result of interference with the nerve supply to the external sphincter and with the sensory supply to the urethra. Our findings, therefore, are variable, and we believe it is impossible to predict, except in a general way, the type of bladder which will be the result of injury at a given level.

Several months ago, we ran a series of cystometograms to aid in the differential between the autonomous and the automatic bladder. Although the differential is possible by cystometry, the results obtained did not seem to warrant the work entailed since the diagnosis can be made as well clinically and treatment is the same, regardless of the type of pathology encountered. We have, therefore, discontinued the use of the cystometer in evaluating these patients.

We have seen several cases of bladder neck obstruction as a result of spinal cord injury. With hypertrophy of the detrusor muscle, one would expect complete emptying of the bladder because of more efficient bladder contractions. The internal vesical sphincter, however, is actually the rim of the detrusor and this may enlarge in the general process of hypertrophy with resulting bladder neck obstruction. Transurethral resection may be indicated, therefore, in the presence of bladder trabeculation, high residual, and the presence of a prominent sphincteric ridge which is really a part of the process of general detrusor hypertrophy.

Should all the above methods fail in producing a satisfactory bladder, the patient must have drainage of the bladder constantly, either through the medium of a suprapubic cystotomy or a perineal urethrotomy. We have not been forced to do either of these procedures as yet nor have we done any surgical procedures on patients with incontinence in order to form an artificial sphincter. These latter have been handled satisfactorily thus far by using the collapsible rubber urinals attached to the leg while the patient is ambulatory.

The foregoing presents the methods and the theories behind them, used in this hospital to obtain a properly functioning, "social" bladder for the paraplegic patient. Captain Medler will present a statistical review of the results achieved.

PRACTICE AND RESULTS

CAPTAIN ROBERT E. MEDLER, MC, England General Hospital

A review of the urological histories of paraplegic patients in this hospital has shown that the treatment of the urinary system, with the primary consideration being an attempt to keep the tract clean and free flowing, has followed a general routine. Those patients demonstrating an initial physiologically or anatomically complete paralysis had cystotomies performed. Those with bladder sensation or partial paraplegia were carried on urethral catheters, either indwelling or intermittent, until control was established. Of the 122 cases in this hospital which have been reviewed, 91 or 74.6% have had cystotomies, only three of which were perineal. In injuries which actually involved the spinal cord, 80% of the cases had cystotomies, while 57.5% of the cauda equina injuries had cystotomies. Cystotomies were allowed to function for an average of 2 months, the tube, barring complication, of course, was then removed, and an indwelling urethral catheter left in place to allow healing. The vast majority healed promptly, were dry in a

CAPTAIN ROBERT E. MEDLER, MC (Continued)

few days and solid in 4 to 6 weeks. It was then possible to try to establish some sort of bladder control. The goal has been to establish a social bladder, either automatic or voluntary, and it is felt that most patients can or will be able to get along without mechanical drainage.

At the present time, of 122 patients, 4 have functioning suprapubic cystotomies; 40 are on urethral catheter drainage; and 78 are catheter free. Of the 40 patients on catheter drainage, 8 are post operative cases (urological or otherwise); 7 have reopened their suprapubic cystotomies; and 3 are unable to void by any other means. The remaining 22 are on tidal drainage. Of these 22, 9 have severe muscular spasm which makes trial without catheter impractical; 3 are on Stryker frames and are difficult nursing problems; and 10 are in the 4 to 6 week preparation period prior to removal. Of the 78 cases without catheter, 42 are automatic; 27 are able to express their urine adequately by straining combined with Crede pressure; and 9 have normal voiding. We have used tidal drainage a great deal in an effort to stimulate automaticity and to stretch spastic bladders, and feel that it has been of value in this regard.

A break down of cases in an effort to correlate the level of lesion with the ability to establish automaticity and voluntary control is as follows:

LEVEL OF INJURY	ON CATHETER DRAINAGE	AUTOMATIC	NORMAL OR VOLUNTARY EXPRESSION
Cervical 11	3 (27%)	4 (36%)	4 (36%)
High thoracic 27			
D1 - D6	12 (44%)	10 (37%)	5 (18.5%)
Low thoracic 44	18 (43%)	16 (36%)	7 (16%)
D7 - L2 & L1			
Cauda Equina 40	7 (17.5%)	12 (30%)	20 (50%)
TOTAL 122	40 (32.8%)	42 (34.4%)	36 (29.5%)

NOTE: There are 4 cases at present with functioning suprapubic cystotomies.

Aside from the higher percentage of cauda equina injuries which regain normal or voluntary control of micturition, which can be reasonably explained by the incomplete neurological trauma, there seems to be no definite relationship between the lesion level and the establishment of bladder control or automaticity.

MAJOR UROLOGIC COMPLICATIONS AND TREATMENT IN THE PARAPLEGIC PATIENT

MAJOR SAMUEL L. RAINES, MC, Chief, Urological Section

In discussing the major complications of the urinary tract in the paraplegic patient, we may divide the subject into two main divisions:

1. Infection
2. Stone formation

Infection usually begins in this type patient with the first invasion of the bladder, either by a urethral catheter or by a suprapubic tube. Practically all such bladders are infected and the severity will depend upon the virulence of the infecting organism and upon the individual resistance of the patient. The percentage of the various organisms found in our series is as follows:

TYPE AND FREQUENCY OF BACTERIA OCCURRING IN CULTURE OF BLADDER URINE OF FIFTY-TWO PATIENTS WITH SPINAL CORD INJURY

BACTERIUM	IN PURE CULTURE		IN COMBINATION WITH OTHER ORGANISMS OF THIS TABLE		EITHER IN PURE CULTURE OR IN COMBINATION WITH OTHER ORGANISMS OF THIS TABLE	
	Number of Patients	Percent of total number of Patients	Number of Patients	Percent of total number of Patients	Number of Patients	Percent of total number of Patients
Aerobacter aerogenes	13	25.0	22	42.3	35	67.3
Escherichia coli	7	13.5	22	42.3	29	55.3
Bacillus proteus	3	5.7	5	9.7	8	5.4
Streptococcus Non-hemolyticus	0	0	12	23.1	12	23.1
Bacillus Pyocyaneus	0	0	4	8.0	4	8.0
Streptococcus Hemolyticus	0	0	7	13.5	7	13.5
Alkaligenes fecalis	0	0	1	2.0	1	2.0
Staphylococcus aureus	0	0	1	2.0	1	2.0
MOST FREQUENT COMBINATIONS:						
Escherichia coli					3	15.4
Aerobacter aerogenes						
Escherichia coli						
Streptococcus non-hemolyticus					3	5.7

NO OTHER COMBINATION OCCURRED MORE FREQUENTLY THAN 4% OF THE TOTAL NUMBER OF PATIENTS.

With the aid of sulfa drugs and penicillin, and more recently streptomycin, it has been possible to control these infections far better than formerly but as long as there is a tube draining the bladder, the complete elimination of these organisms is difficult and the infection tends to recur at intervals. This is true in spite of the most careful technique in irrigating and cleansing these tubes, although the more careful the asepsis, the less the infection. It has been our experience that the type of solution used in irrigating the bladders and kidneys is not significant and stones have been known to form in a bladder that was being vigorously irrigated with M or G solution.

Pyelitis is the natural result of bladder infection and in cases where such infection recurs, one would expect to find many cortical abscesses. Such has not been our experience or if present, they absorbed readily under routine treatment, for no case of cortical abscesses or carbuncle has been operated in our series. Pyelitis usually responds well to chemotherapy, penicillin or streptomycin plus plenty of fluids. If drainage is poor, a ureteral catheter is inserted for drainage and irrigation.

Urethral abscesses due to an indwelling catheter occurred in two of our cases. The resulting peno-scrotal fistula healed spontaneously in both of these men following removal of the catheter and regular dilatation of the urethra. One other such case occurred in a bilateral amputee who was confined to his bed, and his fistula remained open necessitating operative repair. The only way to heal such fistulae is to first divert the urinary stream by means of a suprapubic tube. Then, after allowing time for the inflammation around the tract to subside, it can be excised and the mucosa of the urethra closed. A small urethral catheter is best left in place.

Epididymitis with abscess formation has occurred in five cases and orchidectomy was necessary in two of these. One case developed epididymitis as the result of straining in an attempt to void following the removal of a retention catheter. No doubt this catheter produced some irritation and set the stage for the epididymitis which occurred later.

By far the most important urinary complication in the cord cases is calculus formation. It is well recognized that both infection and stagnation play a major part in formation of calculi in the urinary tract. Also, there is a definite connection between inactivity and the deposition of calcium in the urinary tract. The physiology and cause of this is not clear, but it is fairly certain that in the recumbent patient calcium leaves the bones and is excreted in increasing amounts through the urinary tract. Stone formation is favored if the urine is allowed to collect and remain in the dependent calices of the kidney. Hence, early and continued ambulation is of the greatest importance. In cases where this is

not possible, then sitting erect in a wheelchair is helpful and for bed patients exercises and frequent turning are essential.

Of 108 patients in our series, 14 had kidney stones, 29 bladder stones and three patients had both kidney and bladder stones. Many lesions are high in the cord so that no pain is experienced from kidney pathology and hence pain is not a symptom in the diagnosis of stones in these cases. The diagnosis must be made by urinalysis, temperature elevation and X-ray. It must be remembered that normally about 10% of the genito-urinary stones are non-opaque and I believe in these patients the percentage is even higher.

Retrograde examination of the kidneys is not done routinely because of the danger of spreading infection. Hence, intravenous urography is resorted to regularly in these patients, not only for immediate diagnosis, but for comparison later in determining whether a stone is enlarging, changing position, shape and so forth. It is also helpful in demonstrating caliceal obstruction and retention.

Conservatism is essential in the treatment of calculi in the kidney and ureter. With the widespread prevalence of urea-splitting organisms in the GU tract and the resulting tendency to stone recurrence, it is obviously desirable to avoid surgery; but in these patients where there is inactivity and often inability to empty the bladder completely along with general debility, the need to avoid surgery is much greater. We have all seen patients who have passed stones and completely emptied pelves of calculi and infection simply by getting up out of bed and becoming active in the upright position. One such case in this hospital had many stones in each side of a horseshoe kidney. It was decided not to interfere surgically until he was ambulatory. Four months later, two X-rays showed no shadows in either side. Hence, we all agree, I believe, that surgery should be postponed in these patients until they are ambulatory and thus have the best possible chance to avoid recurrence.

In certain cases, however, it is necessary to perform some type of surgical procedure without delay to relieve pain and infection and save the kidney from destruction. Stones in the ureter or at the uretero-pelvic junction may obstruct and force us to interfere. It is our practice here to insert as large a ureteral catheter as possible into the kidney pelvis on the involved side. This will either bypass the stone or frequently push it back into the pelvis where it is not obstructing. The catheter is left in place for a few days and then removed. If no further blockage occurs, the stone is dealt with in due time under the best possible conditions. If the obstruction does recur and infection and fever are present, then the catheter is reinserted to give drainage for three to five days and after the general condition of the patient is improved by means of blood transfusion, fluids, chemotherapy, etc., operation is performed.

The type of operation and incision will naturally vary with the pathology present and the individual preference of the surgeon. For stones in the ureter it would seem that anterior incisions are preferable partly because any urine draining from the wound would be less likely to cause irritation and sores on the back. These wounds are drained with Penrose drains without attempting to close the ureter.

Calculi in the pelvis or calices present a different problem in that here all possible measures are taken to prevent recurrence. An obstruction must be removed and the infection eliminated if this is to be accomplished. Through a flank incision, the uretero-pelvic junction is carefully exposed and inspected for obstruction of any kind. In several of our cases, aberrant vessels or bands were found and removed. In two cases there was constriction at the uretero-pelvic junction with no apparent cause. This constricted area was incised longitudinally and allowed to granulate over a T-tube after removal of the stone. In another, the ureter was inserted high in the pelvis causing the uretero-pelvic angle to be very acute and leaving a distended and stagnant lower pelvis. This deformity was corrected and subsequent intravenous pyelograms showed good drainage from this kidney.

It might be well to point out that the use of a T-tube for uretero-pelvic obstruction has not been wholly satisfactory. If the lower arm of the tube is short, it produces a fixed and rigid upper ureter making subsequent surgery difficult in case this became necessary. This is partly avoided by having the lower arm of the T-tube longer, thereby mobilizing the entire upper and middle ureter and producing much less fixation.

A nephrostomy tube has been used for irrigation and drainage in nearly all of our operations for kidney stones. Where both upper and lower calices are involved and infection is prevalent, we have placed small tubes in both upper and lower areas, thus providing a through-and-through irrigating system. We have done this in at least three cases. A nephrostomy tube provides not only a more convenient and sanitary method of drainage, but (and more important) it enables us to wash the kidney calices and pelves clean of infection and removes particles of sand and calcium deposits that might play a part in reforming stones. The nephrostomy tubes are left in place until the infection disappears. It is desirable, though not always possible to secure a negative culture. After three to four weeks the tube is removed and it can be reinserted if infection returns.

An effort is made to remove the stone through a pelviotomy, using the Randall stone forceps, because nephrotomy always destroys some of the cortex and sometimes leads to hemorrhage, infection or other complications that make later nephrectomy necessary. Naturally the conservation of kidney tissue is of primary

importance in these patients, and we have been fortunate in this installation in that nephrectomy for stone in the kidney has not been necessary in our series. In cases of multiple stones in the kidney, the use of X-rays has greatly aided us in locating some of the stones, and at Colonel Lyons' suggestion, we are now taking a picture after we feel all calculi are removed. This might well reduce our percentage of recurrences. Instead of intermittent irrigations for the nephrostomy tubes, we often employ a slow, continuous drip through the tube. This has been an aid in keeping the tubes from blocking and also keeps the pelves clean at all times.

Stones in the upper ureter are either bypassed or pushed back into the pelvis with a ureteral catheter as mentioned previously. Those in the lower ureter will usually pass of themselves if given time. If urine is passing by the stone and infection is not present, ample time is given for passage of the stone. If it is not passed or if infection or obstruction intervene, we insert a large ureteral catheter using spinal anesthesia if necessary. This catheter is left in place 48 to 72 hours and then removed. Sometimes prostigmin, 1 ampule every two hours for three doses is used to aid in expelling the stone. In some we have extracted the stone with a wire basket, though this procedure is not without its risk. About 90% of lower ureteral stones can be passed by the use of these or other conservative measures. We have operated on only one lower ureteral stone which had gotten quite large in a dilated ureter. In a patient who has sensation in the kidney area, the absence of pain should not be allowed to mislead the surgeon into overlooking the possibility of an obstructing stone because occasionally the absence of pain means complete blockage of the ureter with suppression of urine and it is in this type of case that immediate drainage is necessary.

Bladder stones occurred in 29 cases. These stones are removed by crushing with Lowsley's utility forceps and then evacuated by the Elik evacuator. If this is not possible, then a cystotomy is performed. Extra efforts are made to avoid cystotomy, however, since in these cases wounds are often difficult to heal as shown by Capt. Sanderson earlier.

The methods used to prevent recurrences of stones are about the same as those that should be used to avoid the formation of these stones in the first place. In neither case are we altogether successful, but the more important and useful procedures to recommend are:

1. Irrigation of the kidney through the nephrostomy tube for three to four weeks postoperatively. Though solutions M and G have been rather disappointing, there are some cases where these solutions apparently help in dislodging and removing certain types of small calcific deposits. When tolerated, I feel solution M is definitely worth trying in such cases. It can be used

alternately with acetic acid or other less irritating solutions.

2. Fluid output to be maintained at 2500 cc. minimum per day.
3. High caloric and high vitamin diet. Milk is so useful in the general body nutrition that I hardly think it wise to completely eliminate it from the diet for long periods of time, even though it does contain a high calcium percentage.
4. Ambulation. The patient must be out of bed if at all possible. If not, then vigorous bed exercises and frequent turning are essential.
5. Repeated urinalyses and X-ray studies to detect recurrence.
6. Urine to be tested for the PH and acidifiers used if necessary to keep the urine acid.

In our series no death has resulted from urinary complications. This is remarkable but not exceptional, for last April in Martinsburg Captain Petroff reported only one death in 70 cases at Newton D. Baker General Hospital and Major Joelson had only two deaths out of 31 cases of stone and pyelonephritis at Crile General Hospital. A few years ago it was an accepted fact that most of these patients died in a few months from urinary complications. This contrast is further proof, if any were needed, that a new day is here for the paraplegic patient.

In closing I would like to repeat what I said in Martinsburg at the last paraplegic conference. The Medical Corps has an unparalleled opportunity of investigating why calcium leaves the bones and is excreted through the urinary tract in the recumbent and inactive patient. My plea is for trained research men with adequate facilities and help who can make a comprehensive and intensive study of this and related problems.

EXPERIENCE AT HALLORAN GENERAL HOSPITAL

LT. COLONEL THOMAS P. SHEARER, MC

The urological management of traumatic paraplegia at Halloran General Hospital is directed toward ambulation with effective bladder control and eventual sterile urine. We feel that the latter can be achieved by removing all drainage tubing, and healing the suprapubic fistula as rapidly as possible and allowing the patient to void automatically or to attempt voiding by straining and pressure over the bladder.

Our procedure usually starts with removal of the cystostomy tubes following surgical closure of decubitus and initiation of indwelling catheter drainage. The retention catheter is attached to a closed drainage system until the suprapubic fistula is healed. When this occurs, the indwelling catheter is removed and the patient is allowed to urinate automatically. Tidal drainage is instituted after the suprapubic fistula has healed when prolonged catheter drainage is contemplated and the patient is in bed. In those cases unable to void automatically or on straining, tidal drainage is also used in order to encourage development of bladder muscle tone and prevent the contracture which tends to accompany prolonged catheter drainage of infected bladders.

When the patient begins to void after the removal of all the catheters, intermittent catheterization is done at intervals of one to three days until there is no residual urine. This usually occurs in about one or two weeks. If the patient does not void and tidal drainage is not instituted, he is catheterized intermittently for a period of observation. Mat and ambulation exercises are proceeded with. Following ambulation exercises, some of the patients begin to void automatically. If after observation and ambulation, the patient does not void, cystoscopy and cystometric studies are done. Vesical neck obstructions by a true fibrotic bar has not yet been observed. We have two cases where a spastic internal sphincter ridge may require transurethral resection, which will be performed after an adequate period of observation.

Cystoscopic examination is not resorted to except to assay bladders with persistent urinary fistulae and for confirmation of urinary calculi. At cystoscopic examinations in some of the cases that have flaccid bladders, we have observed trigonal contraction which not only keeps the internal sphincter region wide open but also pulls open both urethral orifices so that they are gaping and almost golf-hole in character. The intravenous pyelogram has confirmed the presence of ureteral dilatation in these cases and we feel that tidal drainage is contraindicated, where reflux up the ureter is certain to occur and is not preventable. In those cases we rely on either intermittent catheterization or indwelling urethral catheters with forcing of fluids.

Recurrent or persistent suprapubic fistulae are most frequent where the suprapubic incision is fixed and is low over the symphysis pubis. It has been further observed that vesical calculi are often present where suprapubic fistulae fail to heal and the presence of vesical neck obstruction must be kept in mind. A number of cases has been found in which black silk sutures were used to close the muscle and fascia and were acting as foreign bodies. After preliminary curettage of the fistula with removal of the black silk sutures, some of the fistulae have closed rapidly. In others it is necessary to revise the wound. In these cases,

whenever the bladder is found fixed either to the skin or to the rectus muscle or sheath, it is freed from these adhesions and we find as others do, that the free bladder tends to become automatic much more rapidly than do the ones bound to the anterior abdominal wall by adhesion.

In the presence of ureteral calculi, cystoscopic examination is done, the calculi are encouraged to pass spontaneously or by dilatation of ureteral orifices wherever possible. Bladder stones have been removed by litholapaxy wherever possible. We have been using the Bigelow Lithotrite and a Lowsley utility forceps for litholapaxies.

Renal and ureteral stones are removed surgically after attempts at ureteral dilatation have proven unsuccessful. Cystostomy has been done in one case for a large calculus which had impacted into posterior urethra and was blocking the channel.

Of a total of one hundred and four patients presently in the hospital, six have open suprapubic fistula and are under observation; and may possibly be resected. Eighty-eight of the patients are dry and voiding. None of these patients have true automatic bladders. Sixty-nine of these patients have flaccid bladder from which the urine can be expressed by straining and by pressing over the lower abdomen. Of these cases, fourteen have residual urine and this appears to be decreasing in amount as the patients progress in ambulation. Calculus formation in the urinary tract has been observed in 20% of the cases of which 4 were in the kidney, two in the ureter and 16 in the bladder. Of this number, 15 have been operated to date. 4 Periurethral Abscesses and 12 cases of acute Epididymitis have been observed.

Pyelonephritis is another common finding and in reviewing the statistics, it has been found that 27 patients had recurrent attacks of chills and fever before arriving at this hospital. After arriving at this hospital, 28 cases had recurrent attacks of chills and fever. At present there are two patients who have acute pyelonephritis and are under treatment.

SUMMARY: Ambulation helps in the relief and prevention of:

1. Genito-urinary tract infection.

- a. Promotes better drainage from automatic bladders, diminishes the amount of residual urine in flaccid bladders.

2. Genito-urinary tract calculi.

- a. By diminishing stasis.
- b. By decreasing infection.

- c. By diminishing the amount of calcium excretion found normally in bed patients.
- d. By promoting easier acidification of the urine.

The above condition appeared to be reversed in bed patients. It has been observed in Halloran General Hospital, that as the patients progressed in their ambulation, bladder capacity becomes greater, the urine tends to become crystal clear and better control is maintained over the act of micturition.

DISCUSSION

DONALD MUNRO, M.D., Surgeon-in-Chief, Department of Neurosurgery, Boston City Hospital, Boston Mass.

It is hard to take an impartial point of view when you are a protagonist of one of the subjects under discussion. However, I will try to be as impartial as I can and start out by making a profession of faith. It is especially important to have faith and to have a goal to reach when dealing with paraplegics. My profession of faith is this. I am convinced that every patient who has sustained a spinal cord or cauda equina injury, and is intelligent and cooperative has the right to expect infallible twenty-four hour control of urination by the time he leaves his doctor's care. Only those whose bladder has been denervated because of bilateral destruction of the parasympathetic plexuses or the lower four sacral segments or roots will need any extraneous aids such as a catheter or urinal to accomplish this. Nothing less than the ability to lead a normal social life and the capability of earning their own living is acceptable as an end result for these patients. Control of urination is an essential preliminary to self-support.

I was distressed yesterday at the implication voiced by many speakers that a wheel-chair life was a good enough life for a paraplegic. This is so far from the truth, providing a proper approach is made to the problem and providing all concerned are willing to take the time and make the effort to attend to all the innumerable small details that go to make up a successful whole, that I cannot protest too strongly against it even if it existed as nothing more than a possibility in the minds of the speakers. Infallible twenty-four hour control of urination together with ambulation, a normal social life and the ability to earn his own living are well within the bounds of possibility for every paraplegic.

Another problem that affects the paraplegics and that should receive rather more realistic thought than appears to have been given to it is that of developing or rebuilding initiative in them. This is difficult enough in civilian life but is necessarily more so when the patient is a wounded veteran. I do not intend and certainly have no wish to belittle the remarkable and painstaking

services that have been and are being rendered by the Red Cross and all the ancillary services that work under their direction. It is not possible to thank them enough for what they have done. That very fact however forces us to see to it that their efforts are neither overdone, wasted nor harmful. Paraplegics tend to "let George do it" because the attitude of the public and a large section of the medical profession is that nothing else is possible for them. Instead of learning bladder control they come to depend on urinals and a penile clamp; instead of ambulation they move about in wheel-chairs; instead of self-support they say, "I'll live off the Veterans' Administration for the rest of my life." This is understandable and quite to be expected but it should not be condoned or encouraged. Instead of being provided with urinals so that they can attend a ball game and keep respectable, their urinals should be taken away and only those who have learned control of urination be permitted to sit on the bleachers. Instead of being pushed around in a wheel-chair by a Gray Lady so that the paraplegic can broaden his interests and his life, he should be provided with caliper splints and crutches, taught to use them and then be made to go under his own power to the distant places in the hospital and thus develop his own initiative and at the same time lighten the burden of the Red Cross. Trips to the theater, to concerts and the like, should be given paraplegics as rewards for accomplishment and not used as a method of filling in time that hangs heavily on the man's hands only because he is unable or unwilling to make the effort to put it to practical use. The doctors' share in this development of initiative is no less important than the paraplegics'. It will be effective only if he is satisfied with nothing less for the patient than the minimum I have labeled as my profession of faith.

Colonel Scarff gave what was, to my mind, a very able discussion of a fundamental subject. This has to do with the diagnostic classification of patients with cord injuries. This is important because unless we all know what the other person is talking about, nothing but confusion will result. This is particularly true when bladder function and its change or loss is referred to. I believe that when a cord has been anatomically transected above the second sacral segment and there is no vestige of neural connection between the cut ends, the diagnosis should be spoken of as an anatomical transection at such and such a level. Previous to a period of training to "urinate by the clock" and providing the bladder has not been allowed to shrink unduly, these patients should all have a reflex or "automatic" bladder. Proper training with this kind of bladder function as a fundamental and providing an active mass reflex is not present, will eventuate in infallible twenty-four hour control of urination. If the mass reflex is present and active, an anterior rhizotomy will have to be done before training can be started. This holds true also for those patients whose cord is so transected as to produce a physiological, functional or complete symptomatic transection but in whom a vestige of neural tissue connecting the two cut ends prevents anatomical transection and hence the development of a mass

DR. MUNRO (continued)

reflex. Rhizotomy is never necessary in such cases and infallible twenty-four hour control of urination the only acceptable end result as far as the bladder goes. The bladders that have been denervated can also have infallible twenty-four hour urinary control but only if the patient is willing to wear an inlying catheter constantly and to use tidal drainage at night while in bed. All other cord and cauda equina injuries should have as an end result nothing less than a normal bladder as good as it was before the injury.

Captain Sanderson talked about cystostomies. I would like to put in a plea for surgical closure of these openings. I know that it is customary to let these fistulas close themselves but I believe that that is unsurgical. I think it is better surgery to excise the fistula and scar and close the bladder and abdominal wall with layer sutures and appropriate drainage. As long as the fistulous tract is present, whether open or closed, the bladder is attached to the abdominal wall. This is abnormal and if it can be eliminated and normal relationships reestablished the bladder will function more efficiently. I do not feel that doing cystometrograms is a waste of time. On the contrary, I feel very strongly that without the information that is obtainable only from them the paraplegic's bladder cannot be properly treated and hence he will be deprived of the kind of end result that he should have. Captain Medler was extremely interesting. I do not know of any comparable data. It gives us something to shoot at.

The problem of infection as a result of an indwelling catheter is one which bothers all genito-urinary surgeons. I believe, however, that it can be handled more easily than one would be led to expect from the literature. I have had such complications as urethritis, epididymitis, prostatitis, periurethral abscesses and even perforated bladders in my paraplegics. On investigation, however, it was only too readily demonstrable that each such complication developed only because of either using too large a catheter, using a stylet catheter or from improper attempts to crush a bladder stone. Too large catheters interfere with the flow of urethral secretions which, when backed up, cause urethral and paraurethral infection, or else cause surface necrosis in the urethra from pressure with subsequent infection and complications or both. The use of stylet catheters and the performance of litholapaxy are dangerous because the patients do not feel pain and when their urethras or bladders are perforated or compressed no complaint is made. I am convinced that all such complications will be eliminated - and this has been my experience in the last ten years - providing the size of all catheters is limited to 18 F and providing also stylettes are not used as an aid to the insertion of catheters, and bladder stones are not crushed until they have been softened by exposure to solution G and then only if a skilled operator does the actual crushing. When catheters of proper size are used they should be removed, cleaned, resterilized and replaced not less often than once a week.

COLONEL LYONS:

I have received a message that the Surgeon General has just

arrived in the hospital. The proceedings will be interrupted to welcome him.

BRIGADIER GENERAL CHAPPELL:

It is a real honor to me, ladies and gentlemen, to introduce our distinguished Surgeon General, Norman T. Kirk. I have an idea that everyone in this room is intimately acquainted with General Kirk. If that is not the case, for those who are not, I would suggest that from this day on you become intimately acquainted with him because if you don't you lose something out of your life. Some years ago I took the liberty to write a little verse about General Kirk which I will not repeat here. In this little verse, I tried to picture his life and what he likes to do - hunting, fishing, enjoying a good meal, and the wish for that sort of life, and he and I hoped in those days that he would some day be enjoying that sort of a life - but being a man interested in world affairs and especially a man interested in the sick and wounded, he did not do that about which he had dreamed, though probably he still is looking forward to it. He has many characteristics which we all love. He is totally indifferent to the rank, grade, or color of a patient. If you know him you find that out. The only thing he is interested in is the man or woman patient. His attitude toward all patients is always a human one. I recall, for example, there was a stenographer in the X-Ray Department. She was a charming young girl who had lost one arm and who had a terrible time from the readjustment standpoint until General Kirk stopped and spoke to her every day so that he kept her morale up. She developed into a normal young woman. She became devoted to him more than anything else because in his relationship with her, he kept her mental reactions on a normal level. It is a great honor for us here at this hospital to have our Surgeon General visit us again. His words are always inspiring. My many years of association with him have certainly been inspiring to me. It now gives me great pleasure to introduce to you our Surgeon General, Norman T. Kirk.

OVERALL POLICY IN THE ARMY

MAJOR GENERAL NORMAN T. KIRK, Surgeon General, U. S. Army

I am very glad to be with you here today at Thomas M. England General Hospital for the Conference on Spinal Cord Injuries. We are most grateful to you who have done so much to win this war. Nothing has ever been done as well as this job has been done for this particular group of patients. I know it will be up to the Army to continue for a year or more to help these paraplegics. We are planning, as hospitals close, to transfer them with the group caring for them to hospitals remaining open and to send them to hospitals eventually to be taken over by the Veterans' Administration. This is the best we can do for this group of patients.

I was asked to talk about the problems of the Army, especially of the Medical Department, of which there are quite a few. You know as well as I do what would be happening in the world today if we had lost this war. Many of you have been overseas and know,

as I do, what a splendid job was done to save the lives of our wounded. An outstanding contribution has been made by the American nurse in overseas theaters. Our enlisted men and medical technicians have also set up an enviable record. The whole job was outstanding and a big one.

General Bliss recently raised the question of why were we not getting more doctors out of the Army. We have a good reason. We have treated more than fifteen million patients in our hospitals since the start of the war. As you know, we reached a ceiling of 315,000 in the ZI in August. During the month of May patients were coming home at the rate of 56,000 a month and not many doctors came home with them. Then we did get some doctors home and were redeploying them, putting high point men in the hospitals. Then on VJ-Day we had to go into reverse and release those with high point scores. It was probably harder on the patients than on any of us. The patient-doctor relationship is a most important thing to the patient. It maintains his spirits when he becomes a casualty.

It has been a long war but we did win. Our job is still not finished; there are still many patients in our hospitals in this country and overseas, some 225,000 of them. These are the men who won the war for us.

This brings us face to face with the problem of how to take care of our patients who must be returned to civilian life in the best possible physical condition. With the specialists we have used in this war, had we had four to six months more of their time we could have cleaned up the job. Now I am worried about whether we can do it, because many of the officers on whom we are depending have sufficient point scores to be eligible, and want to get out. It will only be through the help of these officers that the Medical Department can accomplish its mission and do the job it promised to do. It can't be a matter of just signing a paper and forgetting it. I saw at one place about 287 neurosurgical patients, which will require three months at the very least to clean up. At another hospital I saw about 600 patients requiring plastic surgery - with the doctor about to go home to a teaching job. I don't know who will finish the job that must be done, but the medical officers want to go home.

Technically trained enlisted men with high point scores will be discharged; likewise civilian employees. We never did have enough personnel to do the job the way we would have liked to do it.

We have enough nurses to release all those who have sufficient points. As you know, we hope to separate some 12,000 doctors, 20,000 nurses, and 2,000 dental officers by January 1. We have been promised they will be returned from overseas and they are being separated as rapidly as separation centers can do so. Separation points have been set up in hospitals where their own men can be discharged. This puts an additional load on the hospitals. I am in hopes - and

I know and feel - that many officers will remain and help us finish our job. There are only about 1100 Regular Army medical officers, all but some twelve of whom have done administrative work only in this war. Some have done very well and I am proud of them.

Let me tell you again how much I appreciate the splendid job all of you are doing. I hope this will continue until those who gave so much to win this war for us have received what is due them.

Thank you.

COLONEL LYONS:

The discussion on "The Urological Problem" will be continued.

LT. COMMANDER THOMAS I. HOEN (MC) USNR, U.S. Naval Hospital, St. Albans, New York:

Without preamble, I would like to say that in the management of paraplegics at St. Albans, we have tried to follow the general principles as outlined in this two-day conference. Certainly, we agree that tidal drainage is a physiologically sound procedure and is the best method of preserving bladder tone and maintaining bladder capacity. We must admit, however, that in spite of great diligence on the part of all concerned, we are not satisfied with our attempts to obtain an automatic bladder in these patients. These people can never become socially adjusted unless they have a bladder which is continent and they will never be free of recurrent urinary infection unless the bladder completely empties itself at regular intervals. In few of our cases have we arrived at this ideal. The successfully functioning automatic bladder must depend upon a delicate balance between the mechanism of continence and the mechanism of evacuation of neurological deficits. It seems to me that it might shed more light upon the problem if we correlated our bladder conditions with the known cord lesions on the basis of the latter being upper, lower, or combined upper and lower motor neurone lesions rather than on the basis of cervical, thoracic or lumbar lesions. I believe we can say that our patients with urinary retention fall into one of two main groups. First, those with atonic bladders and those with hypertonicity of the external sphincter. I have been skeptical of the reports that retention is frequently due to hypertrophy of the internal sphincter. We have found cystograms very illuminating in this regard and in no case have we found any hypertrophy of the internal sphincter. On the contrary, the usual finding is the so-called funnel bladder with marked dilatation of the membranous urethra and dilatation of the internal orifice to such an extent that the internal sphincter lay far out on the brim of the funnel. In fact, the dilatation of this portion of the urethra was so great in some cases, that one might easily have mistaken it on cystoscopic examinations for the bladder itself, thus assuming that the external

sphincter was the internal sphincter. We were confronted with the problem of incomplete emptying of the bladder in two patients in particular because these patients had recovered completely the use of their legs and appeared to be normal individuals in every way except that they were subject to recurrent bouts of chills and fever and the urological studies showed beginning dilatation of the ureters and one could anticipate the usual chain of events leading to hydro-nephrosis and kidney failure. In the first case, cystometric and cystographic studies showed that this patient had normal expulsive power in his bladder which had a capacity of 600 cc, but after forceful evacuation, there was always a residual of 300 or 400 cc. With the idea of lessening the tone of the external sphincter, we blocked the third sacral root on both sides with procaine and the patient was immediately able to evacuate the bladder completely. Successful repetition of this therapeutic test lead us to attempt an operation which I shall describe to you in brief. A small mid-line incision is made over the first sacral segment and a trephine opening made exposing the cul-de-sac of the dural tube. On opening the dura at this point, all the sacral roots are clearly visible and by counting down from the first sacral foramen, the third root can be identified. We then sectioned the motor component of both third sacral roots. The patient never had any residual following this procedure nor was he incontinent. It must be assumed that the third root is the main contributor to the pudic nerve but that contribution from the second and fourth are sufficient to maintain sphincter control. I think it is significant that this patient has since returned to civil life, is married and has recently reported that he has noticed no deficit as a result of his third motor root section.

We expect to have more experience with this procedure, but I believe that even in its immature state, it is worth presenting to you for consideration.

MAJOR WILLIAM H. HOLTHAM, MC, Urologist, Cushing General Hospital

There are 86 paraplegia patients at the Cushing General Hospital. Of this group 64 (74%) were originally treated with suprapubic cystostomy and 22 (26%) with urethral drainage. There were no perineal urethrostomies. At the present time we have 10 patients (12%) with suprapubic catheters, 19 (22%) with urethral catheters and 57 (66%) are voiding with no catheters.

Patients admitted with suprapubic catheters are placed on closed type of drainage with self irrigation. Suprapubic tubes are removed and #24 French Foley catheters are substituted. These have been satisfactory as there is little leakage around them and the technicians have no difficulty in changing the catheters, which is done every 7 - 10 days. (Patients with badly infected bladders are irrigated with potassium permanganate with a syringe four times daily, in addition to their closed irrigation.) Solution M is used for all irrigations (a buffered citric acid solution with PH of 4.5). This

has been substituted for boric acid solution because of the high incidence of bladder calculi and alkaline incrustations. Patients with infection on admission are given courses of sulfadiazine and penicillin which have helped in the case of staphylococcus and streptococcus.

Suprapubic catheters are removed as early as possible and patients are placed on #16 French Foley type catheters. These are connected with a closed irrigating system and as soon as the suprapubic sinus is well healed and the cystometric reading shows some return of muscle tone, tidal drainage is substituted. When urethral catheters are removed, the patients are usually given a trial of several hours to see if they are able to void. In addition cystometric readings are used as an indication as to when the catheter may be left out. Following the removal of the catheter, residuals are checked at increasing intervals until three negatives have been obtained.

Complications that have been found are usually from calculus formation or infection. Recently we have been making a survey with KUBs and intravenous pyelograms on all patients and this has not been quite completed. However, to date we have had 23 (26%) patients who have formed calculi. Five patients have passed small bladder stones or they have come out when their catheters have been removed. Suprapubic cystoscopy is of value in checking patients for stones and incrustations before changing over to urethral catheter. Fifteen (17%) patients have developed bladder calculi, of which 8 have been crushed and removed trans-urethrally. Seven patients have bladder calculi remaining. The stones have been removed through the McCarthy panendoscope sheath, the small ones being crushed with the Lowsley utility forceps under direct vision. This instrument can be used in the sheath which avoids undue trauma of the urethra. Several cases of large stones have had to be crushed with the Bigelow lithotrite and then evacuated through the sheath with the Ellik evacuator. Five (6%) patients have had renal calculi; one patient passed his calculus spontaneously and one was removed operatively. Three patients have renal calculi remaining; one of these in addition has a calculus in his left ureter which recently caused a block with acute pyelonephrosis. This was treated conservatively with ureteral drainage and he is quiescent at present. It has been found in the bladder calculi that tidal drainage, using solution M, has been of considerable help in reducing the size of the stones and also in making them much softer and easier to crush. As yet we have been unable to dissolve any of the larger stones completely. It is felt that using solution M entirely as an irrigating solution, will be of considerable help in reducing the incidence of bladder stones. Those that have developed in the past have been in patients who have been on boric acid irrigations and a considerable number of these have been on courses of mandelic acid with restriction of fluid to 1500 cc a day. We feel strongly that fluid intake of these patients should be 3000 cc or higher daily.

Infection has also been a serious problem. Sulfadiazine and penicillin have been of help in caring for streptococcus and staphylococcus infection, but nothing has been found effective against the gram negative organisms, especially the proteus group. We are in hopes that we will have streptomycin available shortly.

In order to keep infections at a minimum, we have tried to do everything possible to keep the drainage system sterile and clean. Recently, vacuoliter bottles have been available and all our irrigating solutions are supplied in these from Central Service. The closed drainage systems are changed weekly and re-sterilized. Gallon jars with a wide mouth obtained from the mess hall are used to collect the urine. The covers to these jars have had a 2" piece of 1/4" copper tubing inserted through the center and soldered in place and a small vent covered with gauze drilled alongside. The drainage tubes are connected to the copper tubing which prevents the tubing from dropping down into the urine and curling up. Also it prevents siphoning of any of the material in the bottle back into the bladder. These covers are sterilized in Central Service and changed daily. Urine bottles are cleaned and changed daily, dilute hydrochloric acid being used to remove any alkaline deposits. They are then sterilized in a large bed pan sterilizer or thoroughly cleaned with disinfectant. One ounce of disinfectant is placed in each bottle before it is connected up. Since we have been using this method, there has been practically no uriniferous odor detectable in the wards.

Particular care is taken of the urethral catheters and the penis. The penis is thoroughly washed with the foreskin retracted twice a day, as is the catheter and any incrustated secretions removed. A small 2 x 2 inch gauze cuff is tied around the catheter at the meatus with a piece of string. These are changed 4 or 5 times daily depending on the amount of secretion around the catheter. They serve an additional purpose in helping to keep the catheter from slipping high up into the bladder. The patients can be taught to look after these. Also in order to prevent the weight of the tubing or any tugging on it from causing pressure on the trigone, a 6" elastic bandage is wrapped around the thigh with a band of adhesive on top of the bandage to hold it securely in place. Two 1/4" cloth tapes are then threaded through holes in the adhesive along the medial aspect of the thigh and the drainage tubing is tied in place, allowing plenty of slack between the urethral catheter and the point at which it is tied. Similarly with suprapubic catheters, a 1" strip of adhesive is wrapped around the distal end and a safety pin placed through it and this is anchored to the binder, to prevent tugging on the bladder. The urethral catheter should be changed once a week, or more often if necessary. Whenever the catheter is disconnected to enable the patient to get up, an alcohol sponge is clamped over the end of the catheter and also over the connecting tube of the drainage set. Patients with mass reflexes sometimes have difficulty with their catheter drainage when these occur and void around the catheters. There seems to be no way of controlling this.

A total of 15 (17%) patients have developed epididymitis - eight patients on the right and five on the left and two bilateral. It has been necessary to do an orchidectomy on two patients and two epididymectomies - one unilateral and a bilateral on the other. In these operative patients the infection was due to gram negative organisms and would not respond to chemotherapy. One patient had had a peri-urethral abscess and sinus which was healed on entry. It was felt in the past that all patients with urethral catheters should be grounded in bed while on this type of drainage and that if you allowed these patients up, the incidence of epididymitis would increase. Of the total of 15 patients with epididymitis, there were 8 who developed this while they were either on suprapubic drainage or had no catheter. It is felt that the most important thing is adequate drainage of the urethral secretions, which is aided by a small #16 or #18 French catheter and drainage is better when the patients are up than when in a recumbent position at all times. All our patients with urethral catheters are allowed up, as are those with suprapubic catheters, with the exception of those patients that are being changed from suprapubic drainage to urethral drainage and their suprapubic sinus has not yet healed. Patients with urethral catheters are allowed to undergo exercises in their wheel-chairs and we are now starting them at ambulation and mat exercises as well. Suprapubic catheters are considered no contraindication to their carrying out the entire ambulation program.

A number of patients have had recurrent temperature elevations which have been difficult to determine the cause, but in the light of no other positive findings, it has been felt that they could be attributed to the urinary tract, and we have had 12 patients with recurrent cystitis and pyelonephritis of this type, in addition to a number with similar episodes. Acute cystitis has been especially prone to develop in patients with bladder calculi.

In some patients there has been difficulty in healing the suprapubic sinus. There were 9 cases in which this re-opened and they were slow to heal. Operative closures were done in 6 cases; two patients have a persistent sinus which has epithelialized and will require operative closure. Four patients have developed small abscesses in their suprapubic scar after it had healed. There is something to be said for operative closure of all of these sinuses at the time the suprapubic tube is removed, as you should get a better closure and a better functioning bladder if it is not tied to the abdominal wall by a thick scar. One patient developed a severe balanitis with extensive ulceration of the skin while lying continuously on his abdomen after closure of a large bed sore. This cleared up with hot saline dressings followed by zinc peroxide powder.

Before the urethral catheters are removed, the patients are instructed while they are up and about during the day to unclamp the catheter every 1½ hours and to attempt to empty their bladders. This is done for a week before the catheter is removed. The patients are connected to their tidal drainage during the night. After the catheter

is removed, the patients are encouraged to follow a regular schedule of voiding, starting at first every hour and one-half and gradually increasing the interval up to every three hours.

Of the 57 patients without catheters, there are 24 (42%) with a reflex type of bladder. Most of these patients have some warning when they are going to void, but have no control over this. There are 33 (58%) patients with varying degrees of a bladder approaching normal with voluntary control. Of these, 17 can void at will, some of them having to exert suprapubic pressure to aid in emptying. There are 13 patients with this type of bladder who in addition have some incontinence at times. This is usually slight and it is most likely to occur while exercising or moving about suddenly. There are 3 patients with a normal voluntary type of bladder but who have a more severe type of incontinence which causes them difficulty excepting when they are in a recumbent position. We have used the Cunningham penile clamp with considerable benefit in these cases, but the patients have to be carefully instructed to change its position frequently because of the danger of forming a decubitus ulcer from pressure. We have had such ulcers develop in two patients which were not severe and healed readily with penicillin cream. The patients with reflex bladders are given rubber urinals to use when they are up, especially during their ambulation and exercise, but they are encouraged to train themselves to get along without these as much as possible as we do not want them to become entirely dependent upon them.

In summary, it is felt that everything should be done possible to combat infection and the formation of stones in these patients. Frequent x-rays and cystoscopic check-ups if necessary should be made so that caluli may be taken care of early. The use of solution M seems of very definite value and we have had no ill effects from its prolonged use. In combating infection the entire technique of drainage and catheter set-up should be kept as sterile as possible. The importance of using a small catheter with careful hygiene cannot be stressed too much. The sulfa drugs and penicillin should be made full use of and streptomycin used when available. Adequate fluid intake is absolutely necessary and we have found several instances of complications arising when patients have been allowed to go home on short furloughs and they forget about taking adequate fluids. One patient in particular drank nothing but popsi-cola while at home on a five-day furlough and he returned to us with a temperature of 103, an open draining suprapubic sinus and markedly dehydrated. It is extremely important that these patients be taught to care for themselves and understand the dangers of not following the proper regime at all times.

CAPTAIN JAMES H. SEAMANS, MC, McGuire General Hospital

It was encouraging to see the early and effective start of ambulation at this hospital. From the urologists' point of view it is to be considered seriously whether or not we are justified in

CAPTAIN JAMES H. SEAMANS (continued)

being satisfied with residual urine, particularly if that residual urine has been infected. So far as I know in these cases, it is not clear exactly what is the factor of obstruction at the internal urinary sphincter.

MAJOR WHITCOMB:

Those of us who have had some experience with Dr. Munro know that he realizes how much we have striven to accomplish return of bladder function in paraplegics. I wonder if we have used tidal drainage long enough at Halloran or England General Hospitals. Many have reached a satisfactory stage in controlling the urinary bladder. Many have partial cord lesions and in most of these, we are going to obtain a perfectly normal voluntary control. In the others, there is considerable and there seems to be discrepancy in the number of automatic bladders which we feel were functioning well at Halloran General, which were nine, and at England General Hospital, it was given, I believe, as forty. Perhaps this is due to the fact that we have not been open as long.

MAJOR GEORGE C. PRATHER, MC, Chief, Urology Section, Ashford General Hospital:

There are several fundamental problems relating to the bladder which have been mentioned today and which I believe need further discussion. In such a discussion we certainly should try to distinguish between statements based on assumption and those based on fact.

In his discussion, Colonel Scarff mentioned that if the paralyzed bladder became overdistended fissures occurred in the bladder mucosa. I do not know the evidence for that statement, but will say that the urine from many distended bladders shows no blood such as one might expect had fissures or cracks developed in the mucosa.

It has also been stated that automatic irrigation of the bladder - tidal drainage - is necessary to prevent a permanent loss of bladder capacity if the bladder is to be on drainage for a long period of time. This is a fundamental point, because if true, tidal drainage should be used in every case. If it is not true, then tidal drainage can be considered as simply a method for bladder irrigation.

Dr. Munro and I are the very best friends and colleagues in Boston so that we can speak frankly to each other without hesitation. He, as you know, is an advocate of tidal drainage. As urologists, we have seen his patients doing extremely well and view with admiration his successes in treating spinal cord injuries. During civilian life with only an occasional paralyzed bladder to look after, I and other urologists had little opportunity to really study

problems of this sort. However, at Ashford General Hospital we have had our share of spinal cord injuries and there has been opportunity to accumulate data concerning the rehabilitation of the bladder. I have used tidal drainage in only a small per cent of our cases.

To quote the status of our patients at Ashford as of October 1st, I can say that 84 per cent of those with partial cord lesions are voiding with voluntary control, and 60 per cent of those with complete lesions are voiding by automatic emptying of the bladder. The bladder capacity of those with partial lesions is usually about 16 - 20 ounces and from 4 - 12 ounces in those with complete lesions. These results, healing of the cystotomy, return of bladder activity and bladder capacity have been accomplished with the closed manual control drainage and irrigation system as shown in TB Med 162 and without tidal drainage. From my own experience I feel sure that tidal drainage is an excellent method of bladder irrigation but that it is not essential for the rehabilitation of the paralyzed bladder nor mandatory for the re-establishment of bladder capacity.

Another point has been mentioned today, namely the deformity caused by the fixation of the fundus of the bladder to the abdominal wall in those with suprapubic cystotomy and the advisability of secondary closure of the bladder. It would seem logical to assume the above but I offer the following observations to indicate that such is not a fact. Neither in civilian life nor in our cases with spinal cord injuries do postoperative cystograms show any definite deformity of the dome of the bladder. Cystoscopic observation of the dome of the bladder rarely demonstrates deformity. Furthermore, I have not found it necessary to do secondary closure of the cystotomy wound in any of over 50 cases of spinal cord injuries at Ashford. We feel, therefore, that secondary closure is not advisable as a routine measure.

I am sure that we all admire the profession of faith which Dr. Munro has mentioned and it appears to be our duty to have our profession of fact as nearly equal to his profession of faith as possible.

DR. MUNRO:

My experience has been that any patient with a cord injury who has residual bladder urine has not been given the best possible end result. I feel strongly that every such patient with the help of his doctor can and should be provided with sufficiently good urinary function as to eliminate residual urine. I am glad that Major Prather said what he did. It gives me an opportunity to say that providing infallible twenty-four hour urinary control is made possible for all paraplegics it makes little difference what method of treatment is used. My experience has been, however, that

DR. MUNRO (continued)

this requirement is met only when tidal drainage has been used. However, I see no reason why manually controlled intermittent irrigation cannot produce the same results and I have no doubt but that it has when under Major Prather's charge. However, I have personal knowledge of another Army clinic where it was adopted as the only method of bladder therapy and where the results were inconceivably bad. It was not the fault of the treatment, but was the fault of the physician in charge of the treatment. Major Prather is such a good surgeon that any treatment in his hands would undoubtedly be successful. Other less able surgeons will, I believe, do better with an automatic irrigating system such as tidal drainage, because it not only eliminates the personal equation but also more nearly approximates physiological requirements than any other method. Cystometrograms have to be done, of course, no matter what treatment is used.

It is a privilege to have been able to listen to Surgeon General Kirk. I think he underestimates the capabilities of the officers in this department, however. I am not as pessimistic as he is about the number of paraplegics that are going to be permanent hospital charges. The interest and ability that has been shown in the care of these patients makes me feel sure that a very large majority will eventually be restored to self-supporting civilian life.

EXPERIENCE AT HALLORAN GENERAL HOSPITAL

MAJOR HELMUTH SPRINZ, MC

When the paraplegic patient arrives in the Zone of the Interior, two complications which follow the initial war injury are preponderant, malnutrition and infection. These are no different from malnutrition and infection seen following other types of war injury, and some of the data we accumulated on severe orthopedic and abdominal injuries could be used in the evaluation of the problem.

From the laboratory point of view, we were particularly interested in the study of the effects of malnutrition on the patient (a study in surgical physiology). The laboratory undertook, also, a study of the surgical bacteriology as it pertains to paraplegics. This part of the subject will be discussed by Lieut. Pulaski. I shall confine myself to the problems incident to malnutrition.

The average weight loss on arrival was 50 pounds. The normal weight of the patient was 160 pounds, the admission weight 110 pounds. We may assume that these soldiers lost all of their fat stores, which amounted to 15% of their body weight, or 24 pounds. The remainder of the weight loss derives from loss of muscle and organ tissue and of blood volume. (There is also some weight loss of the skeleton). The body is composed of 70% water and the rest solids. It is obvious that any discussion of weight loss must be qualified by the knowledge of the fat stores prior to the weight loss and by the study of body water. As practically all of our soldiers were at their peak of muscular development and training at the time of injury, we may assume that their fat stores were constant. The only variable, then, would be the body water. Following Gamble, the body water is distributed in 3 compartments: the blood, the extracellular fluid, and the intercellular fluid. The blood accounts for 5% of the body weight. The extracellular, or interstitial fluid, accounts for 15% of the body weight, and the intracellular fluid amounts to 50% of the body weight.

The study of total body water in the living human is at present not feasible. The only information which can be obtained without difficulty is an estimate of the interstitial fluid and of the blood volume. Fat contains little water, while muscle and organ tissue contain approximately 80% water. It is therefore of great interest to know if any shifts of water occur in the course of such massive weight loss as observed in paraplegics. The interstitial fluid is measured by the sodium thiocyanate method. A specified amount of sodium thiocyanate is injected into the patient and one hour later a blood sample is taken and analyzed for sodium thiocyanate. It is assumed that sodium is distributed evenly throughout the blood and interstitial fluid *, and is excluded from the inter-

* (The two fluid compartments available for the distribution of sodium thiocyanate make up the "available fluid space".)

cellular water by the cell membrane. Blood volume is calculated from the plasma volume and the hematocrit. Plasma volume is determined by Evans Blue Dye Method.

We have found in our series of seriously depleted soldiers with chronic infection that the space available for the solution of sodium thiocyanate is greatly increased above normal. Excess fluid, ranging up to 5 quarts and more were noted. In general, the more serious the condition of the patient is, the higher will be the value of the "available fluid". With improvement, the "available fluid" values will return towards normal.

No feasible method is at present available to determine the exact amount of protein lost in these patients. The weight loss gives an important lead, but we feel that by an additional test, we are able to furnish more objective information. It is by use of the Co Tui Ergograph. Protein loss is intimately linked to loss of strength. The compact bedside ergograph permits the measure of the strength and the recording of it in an objective manner. There are two factors influencing the results of a machine like that. One is the factor of motivation. The second is the effect of special training of the muscle groups of the arm used in pulling the lever. The first point does not apply to our group of patients. All the soldiers are trying hard to show how strong they are and trying their best to work the machine. The second factor is overcome by using the machine only infrequently every two or three days or every week.

The second problem we studied deals with blood and circulation. We determined the hemoglobin, hematocrit and plasma protein in grams per cent in a group of 29 depleted patients with an average weight loss of 50 pounds. We used two groups of controls. One consisted of 50 American medical students of the same height and of the same weight the soldiers had prior to their injury. And a second group were 34 German prisoners of war, working at Halloran General Hospital. The prisoners were of the same weight as our soldiers prior to their injury; however, they were 10 cm shorter than the Americans. The findings are listed in the accompanying table. These figures show a normal plasma protein in the depleted soldiers and a moderate anemia. In order to analyze these findings further, we determined the plasma volume. In the depleted patient, it was slightly diminished. We then determined the blood volume, the R.B.C. volume, the total circulating plasma proteins and the total circulating hemoglobin, as shown in the accompanying tables. There is a marked reduction in blood volume, due to the diminution of the R.B.C. volume. The blood volume shows a 30% decrease as compared with American medical students. The obvious implication to be drawn from these figures is that the blood deficit should be replaced by transfusions. Unfortunately, in the presence of an infection and marked protein depletion, transfused blood does not stay in the circulation. Even massive blood transfusion therapy, giving several times the whole blood volume, did not succeed in correcting the anemia. As a matter of fact, we have come to feel that too frequent transfusions depress the bone marrow and that the best way to combat anemia is by eradicating the infection

and restoring the protein deficit. The very interesting finding of normal plasma proteins in our seriously depleted patients is unexplained.

Our third approach to the problem of malnutrition in paraplegics was by means of nitrogen balance studies. We found that by the time of their arrival at Halloran General Hospital, the catabolic phase of the protein metabolism had ceased and that they were in nitrogen equilibrium. Simply enormous amounts of protein are necessary to compensate for the loss, matters which were discussed in greater detail under problems of nutrition.

Methods of Computing Blood Volume, Red Blood Cell Volume, Total Circulating Proteins, and Total Circulating Hemoglobin

Quantities measured in the laboratory are plasma volume, plasma protein in grams per cent, hemoglobin and hematocrit.

The total blood volume is computed from the plasma volume and the menatocrit:

$$\text{Blood Volume} = \frac{\text{Plasma Volume} \times 100}{100 - \text{Ht}}$$

The total RBC volume is computed from the total blood volume and the hematocrit:

$$\text{RBC Volume} = \text{Blood Volume} - \text{Plasma Volume}$$

The total circulating plasma protein in grams is computed from the plasma volume and the plasma protein (gms.%):

$$\text{Total Circ. Pl. Prot. (gms.)} = \frac{\text{Pl. Vol. (cc)} \times \text{Plasma Prot. (gms.\%)}}{100}$$

The total circulating hemoglobin is computed from the total blood volume and the hemoglobin (gms.%):

$$\text{Total Circ. Hb.} = \frac{\text{Bl. Volume (cc)} \times \text{Hb. (gms.\%)}}{100}$$

	29 Depleted Patients (110 lbs.) * (160 lbs.) **	50 Medical Students (160 lbs.) **	34 Prisoners (160 lbs.) **
Plasma Volume	2750	3200	3200
Blood Volume	4500	6100	5660
RBC Volume	1740	2900	2460
Total Circulating Plasma Proteins	204	220	221
Total Circulating Hemoglobin	583	925	847
Hb. Gms. %	12.9	15.2	15
Ht. %	38.1	47.6	43.5
Plasma Proteins Gms. %	7.4	6.9	6.9
* Present Weight			
** Normal Weight			

STREPTOMYCIN THERAPY

LT. COLONEL THOMAS P. SHEARER, MC
MAJOR ABRAHAM M. KLEINMAN, MC (Presentation)

The therapeutic armamentarium against bacterial infections has been recently increased by the introduction of a new antibiotic agent, streptomycin, which is obtained from *Actinomyces griseus*. In vitro studies have shown that streptomycin is effective against gram negative organisms unaffected by penicillin and the sulfonamides. Included among such organisms are the most common causes of urinary

tract infections which have hitherto been more or less resistant to treatment.

An analysis of the bacterial flora found in the infected urinary tracts of 42 patients hospitalized at Halloran General Hospital is summarized in Table I. Forty-one of these patients had traumatic paraplegia with neurogenic bladders. The other patient had a persistent urinary infection with diverticula of the bladder, secondary to prostatic hypertrophy, the urinary infection having persisted after diverticulectomy and prostatectomy. All infections were polybacterial. *Streptococcus non-hemolyticus*, insensitive to other chemotherapeutic agents, heads the list. It is apparent, from this table, that the other organisms isolated from this group of patients were chiefly gram negative. It is emphasized that these are notoriously resistant to treatment with penicillin and the sulfonamides.

All the organisms isolated from these 42 patients were tested for sensitivity to streptomycin. The results are presented in Table II. It will be noted that the gram positive cocci as well as the gram negative bacteria are usually sensitive to streptomycin. The growth of 55 of the 69 gram negative organisms and of 45 of the 51 gram positive organisms was completely inhibited by 16 units or less of streptomycin per cc. In other words, 80% of the gram negative organisms and 88% of the gram positive organisms were sensitive to 16 units or less of streptomycin per cc. A level of 16 units per cc of streptomycin in the body fluids is clinically feasible to attain.

We have had an opportunity to study the effect of streptomycin in the treatment of urinary tract infections in 20 patients, 19 of whom had traumatic paraplegia and neurogenic bladders. It is well known that patients with neurogenic bladders are subject to numerous and varied urinary tract complications, such as acute recurrent ascending pyelonephritis, chronic cystitis, urinary calculi; urethritis and peri-urethral abscesses; prostatitis; and epididymitis. These complications have been treated with variable success with penicillin and the sulfonamides. Removal of suprapubic tubes with closure of cystotomy wounds, the discontinuance of repeated catheterization together with the establishment of an automatic bladder sometimes leads to the clearing up of the lower urinary tract infections. Some infections clear up following removal of calculi. However, a substantial number of cases are resistant to these measures, and a specific chemotherapeutic agent is welcome. We felt, therefore, that on the basis of laboratory findings, streptomycin would appear worthy of trial.

We began treatment of our first cases with streptomycin in June 1945. At that time little was known of the correct dosage or length of treatment. We decided arbitrarily to administer 200,000 units intramuscularly every four hours, day and night, for three days. The total daily dosage was 1,200,000 units and the total dosage for the three days was 3,600,000 units. The crystalline drug was prepared for use by dissolving it in normal saline to make a solution containing

50,000 units per cc. Seven patients were treated on this regimen and the results on the bacterial flora are summarized in Table III. It will be noted that the drug had no effect in Cases 1 and 6. In Case 2, only the non-hemolytic streptococcus persisted and this disappeared spontaneously two weeks after cessation of treatment. However, at that time a *Staph. albus* was present which was probably a contaminant. This patient was the only patient in the entire group who did not have paraplegia. In Cases Nos. 3, 4, and 7, *B. proteus* and the non-hemolytic streptococcus were still present at the conclusion of treatment. In Case No. 5 all the organisms originally present had disappeared at the conclusion of treatment, but a new organism, *Staph. aureus*, was present. Some of the organisms which disappeared during treatment reappeared one or two weeks after treatment. We feel that this was due to the necessity for repeated catheterization because of a large amount of residual urine, or the presence of indwelling catheters or suprapubic cystotomy tubes. The persistence of strep. non-hemolyticus and *B. proteus* in most of the cases is emphasized.

In the next group of patients, we evaluated the effects of the same total daily dosage for 3 days, but divided in 3-hourly periods rather than 4-hourly periods. This changed the dose to 150,000 units intramuscularly, every 3 hours. Five patients were treated on this schedule, and the results on the bacterial flora of the urine are tabulated in Table IV. It will be noted that the results are substantially the same as in the first group. The non-hemolytic streptococcus persisted in every case and *B. proteus* persisted in every case but one. We feel, again, that the reappearance of organisms after cessation of treatment was due to repeated catheterization, or the presence of indwelling catheters, or suprapubic cystotomy tubes.

Our next case, Case No. 13, D.V., was treated with larger doses. He received 200,000 units every three hours for three days, the total daily dosage being 1,600,000 units, and the total dosage for the three days being 4,800,000 units. The bacterial flora in this patient's urine prior to treatment consisted of *B. proteus*, *K. pneumoniae*, *E. Coli* and streptococcus non-hemolyticus. At the conclusion of treatment, all the organisms were still present except *K. pneumoniae*. This organism reappeared two weeks after cessation of treatment.

By this time it was obvious that much larger doses of streptomycin would have to be used to influence urinary tract infections. Accordingly, the next group of four cases was treated with 375,000 units every three hours for three days for a total of 3,000,000 units per day, and a grand total of 9,000,000 units for the course of treatment. For this group of patients and also for Case No. 18, the crystalline drug was dissolved in normal saline to make a solution containing 100,000 units per cc. The results obtained in this group are shown in Table V. The striking feature is the disappearance of all the organisms originally present in all four cases except for the persistence of the non-hemolytic streptococcus in Cases Nos. 14 and 15.

In Case No. 16 a non-hemolytic streptococcus appeared which had not been previously present and in Case No. 17 two new organisms appeared which had not been previously present. However, in this group as in the previous groups, most of organisms returned following cessation of treatment.

Case No. 18, A.F., was treated with still larger doses of streptomycin. He received 400,000 units every 3 hours day and night for a daily total of 3,200,000 units and a total for the course of 3 days of 9,600,000 units. Prior to treatment urine culture showed *A. aerogenes* and gram positive cocci which could not be further identified. This patient's urine became sterile within 24 hours after treatment and remained sterile throughout the course of treatment. However, three days after treatment, urine culture showed *B. proteus* and *Streptococcus hemolyticus* and 10 days after conclusion of treatment urine culture showed *B. proteus* and an organism in the *Aerogenes Friedlaender* group.

In some of our cases treated with streptomycin, organisms which were still present or which reappeared two weeks after treatment were tested for in vitro sensitivity to streptomycin. These results were compared with the in vitro sensitivity of these organisms prior to treatment and the results are tabulated in Table VII. It will be noted that in Cases Nos. 3, 6, 7, 11 and 12 there occurred a great increase in resistance of the organisms to the drug. This is a most important finding and leads to the inevitable conclusion that cases treated with streptomycin must be treated with large doses early to prevent the development of drug-fastness.

From the clinical standpoint, the results, in general, paralleled the effects on the bacterial flora. Some of the cases which responded poorly to therapy with streptomycin alone, showed substantial improvement following surgical evacuation of pus, or removal of urinary calculi. This re-emphasizes the necessity for adequate surgical treatment as well as the administration of chemotherapeutic agents in surgical infections.

Two cases of extreme interest and importance will now be described. Case No. 19, J.S. This patient was a 22 year old paraplegic who on 20 June 1945 suddenly developed an acute illness manifested by repeated severe shaking chills and a "spiking" temperature which reached 106.8°. Blood cultures were taken daily, and on the fourth day of the illness, blood taken the previous day was reported positive for *K. pneumoniae*.

Streptomycin therapy was begun with a dose of 1,000,000 units, dissolved in 300 cc of 5% glucose in normal saline, and administered in a period of one hour by intravenous drip. In addition, the patient received 250,000 units, intramuscularly, every 90 minutes, the total daily dosage amounting to 4,000,000 units. The temperature subsided by lysis, becoming normal on the 6th day of treatment. On the 8th day of treatment, the temperature rose to 101.6° and patient developed a generalized morbilliform rash. Streptomycin was then discontinued, with the result that the temperature subsided promptly, and the rash

disappeared. Daily blood cultures taken during the illness were all negative subsequent to the institution of streptomycin therapy.

Shortly after the conclusion of the intravenous administration of the drug, the patient had a chill which lasted about 15 minutes. However, he had been having repeated chills since the onset of the illness, and had had several severe chills the same day prior to the administration of streptomycin. It is our opinion that the chill was due to the disease and not to the drug. On the other hand, the fever and rash which developed on the 8th day of treatment were undoubtedly due to the drug. Case No. 20, C.C. This was a 24 year old paraplegic, who developed repeated shaking chills and fever on 1 July 1945, the temperature rising to over 105°. Two blood cultures taken during different chills on 3 July 1945 were reported positive for *K. pneumoniae*. Streptomycin therapy was begun on 4 July 1945 with a dose of 200,000 units every 4 hours, amounting to 1,200,000 units daily. Although blood cultures became negative, the chills and fever persisted unchanged for 3 days. Therefore, the dose was increased to 300,000 units every 3 hours, the total daily dose amounting to 2,400,000 units. This was followed by a slow drop in the temperature to 101°, but the patient continued to have several mild chills daily. On 13 July streptomycin was discontinued. The temperature promptly increased and the chills became more severe. On 20 July 1945 an intravenous pyelogram revealed the presence of a calculus in the right ureter. On the next day, ureteral catheterization was done, and about 100 cc of thick, foul, creamy pus was aspirated from the right ureter. Culture of this pus revealed *B. proteus*. A blood culture taken on the previous day also showed *B. proteus*.

On 21 July 1945, streptomycin therapy was resumed on a dosage schedule of 375,000 units every 3 hours, the daily dosage amounting to 3,000,000 units. Ureterolithotomy was performed on 24 July 1945, following which the temperature subsided and the patient made a clinical recovery. Streptomycin was discontinued on 27 July, patient having received a total of 37,350,000 units.

At the onset of the illness the following bacteria were cultured from the urine: *K. pneumoniae*, *B. proteus*, *E. coli*, and *Streptococcus non-hemolyticus*. *K. pneumoniae* and *E. coli* disappeared within one day after institution of specific therapy, but *B. proteus* and *Streptococcus non-hemolyticus* persisted throughout and after treatment.

A most interesting and startling finding is the change in sensitivity of these two organisms to streptomycin. Prior to treatment each of these two organisms was inhibited in vitro by 16 units of streptomycin per cc. After treatment, there was no inhibition with 256 units per cc, and in the case of *B. proteus*, 50,000 units per cc did not prevent growth.

The conclusions to be drawn from our last two cases, as well

as from our entire series are the following:

1. Streptomycin is effective in the treatment of infections caused by certain gram negative organisms.
2. Streptomycin, to be effective, must be given in large doses: 3,000,000 units or more daily.
3. Insufficient dosage leads to the prompt development of marked drug-fastness.
4. Streptomycin is ineffective where surgical drainage is neglected.

TABLE I

ANALYSIS OF BACTERIAL FLORA IN URINARY TRACTS OF
42 PATIENTS WITH PARAPLEGIA AND URINARY TRACT INFECTIONS

<u>Organism</u>	<u>No. of patients in which found</u>
Strep. non-hemolytic	41 (95.2%)
P. vulgaris	31 (73.8%)
A. aerogenes	17 (40.4%)
E. Coli	11 (26.8%)
K. pneumoniae	11 (26.8%)
Ps. aeruginosa	9 (21.4%)
Staph. aureus	7 (16.6%)
Strep. hemolytic	3 (7.1%)

TABLE II

SENSITIVITY IN VITRO TO STREPTOMYCIN OF ORGANISMS FRESHLY
ISOLATED FROM URINE OF 42 PATIENTS

Gram Negative organism

Streptomycin u/ec.	0.5	1	2	4	8	16	32	64	128	256	total
A. aerogenes	-	2	2	1	4	4	2	2	-	-	17
E. coli	-	-	4	1	2	2	2	-	-	-	11
K. pneumoniae	-	1	3	1	3	2	-	1	-	-	11
P. vulgaris	-	-	3	7	3	13	2	3	-	-	31
Ps.aeruginosa	-	-	-	-	2	5	1	-	-	1	9
Totals	-	3	12	10	14	26	7	6	-	1	69

Gram Positive organism

Staph aureus	4	1	-	-	-	-	-	-	-	2	7
Strept. hemolytic	-	-	-	3	-	-	-	-	-	-	3
Strept. non-hemolytic	7	-	1	12	4	13	4	-	-	-	41
Totals	11	1	1	15	4	13	4	-	-	2	51
Grand Totals	11	4	13	25	18	39	11	6	-	3	120

TABLE III

EFFECT OF STREPTOMYCIN ON BACTERIAL FLORA OF URINE

Dosage: 200,000 units every 4 hours for 3 days

Case No.	Name	Organisms Present Before Treatment	Streptomycin Sensitivity (in units per cc)	Organisms Present at Conclusion of Treatment	Organisms Present 1 Wk. after treatment	Organisms present 2 weeks after treatment
1	J.C.	B. proteus E. coli Strep. non-hem. Staph. aureus	16 8 4 0.5	B. proteus E. coli Strep. non-hem. Staph. aureus	B. proteus 0 Strep. non-hem. Staph. aureus	B. proteus 0 Strep. non-hem.
2	F.S.	B. proteus A. aerogenes Strep. non-hem.	64 8 16	0 0 Strep. non-hem.	Not examined	0 0 *K.pneumoniae
2	M.S.	A. aerogenes E. coli B. proteus Ps. pyocyaneus Strep. non-hem.	32 32 4 16 32	0 0 B. proteus 0 Strep. non-hem.	0 0 B. proteus 0 Strep. non-hem.	*Staph. albus A. aerogenes 0 B. proteus 0
4	B.B.	B. proteus Ps. aeruginosa A. aerogenes Strep. non-hem.	16 16 2 16	B. proteus 0 0 Strep. non-hem.	B. proteus 0 0 Strep. non-hem.	B. proteus 0 0 *Strep. viridans
5	V.S.	A. aerogenes B. proteus E. coli Strep. non-hem.	128 16 4 16	0 0 0 0	B. proteus 0 E. coli Strep. non-hem. Staph. aureus	A. aerogenes B. proteus E. coli Strep. non-hem. 0
6	R.M.	B. proteus Strep. non-hem.	16 4	B. proteus Strep. non-hem. *Staph. aureus	Not Examined	B. proteus Strep. non-hem. Staph. aureus
7	A.A.	B. proteus K. pneumoniae Strep. non-hem.	8 8 16	B. proteus 0 Strep. non-hem.	B. proteus 0 Strep. non-hem.	B. proteus 0 Strep. non-hem.

* New organism

TABLE IV

EFFECT OF STREPTOMYCIN ON BACTERIAL FLORA OF URINE
 Dosage: 150,000 units every 3 hours for 3 days

Case No.	Name	Organisms Present Before Treatment	Streptomycin Sensitivity (in units per cc)	Organisms present at conclusion of Treatment	Organisms Present 1 Week after Treatment	Organisms Pres. 2 weeks after Treatment
8	L.L.	K. pneumoniae B. proteus Strep. non-hem.	64 64 8	0 B. proteus Strep. non-hem.	0 B. proteus Strep. non-hem.	K. pneumoniae Gram positive cocci
9	E.G.	B. proteus A. aerogenes Strep. non-hem.	16 16 2	* Ps. aeruginosa 0 Strep. non-hem.	Ps. aeruginosa B. proteus A. aerogenes Strep. non-hem.	Ps. aeruginosa B. proteus A. aerogenes Strep. non-hem.
10	W.B.	K. pneumoniae "B" B. proteus Strep. non-hem.	8 2 8	K. pneumoniae 0 Strep. non-hem.	K. pneumoniae B. proteus Strep. non-hem.	K. pneumoniae B. proteus Strep. non-hem.
11	C.P.	B. proteus A. aerogenes Ps. fluorescens Strep. non-hem.	4 16 8 4	B. proteus 0 0 Strep. non-hem.	B. proteus A. aerogenes 0 Strep. non-hem.	B. proteus 0 Ps. fluorescens Strep. non-hem.
12	J.N.	B. proteus A. aerogenes Strep. non-hem.		B. proteus 0 Strep. non-hem.	B. proteus 0 Strep. non-hem.	B. proteus 0 Strep. non-hem.

* New organism

TABLE V

EFFECT OF STREPTOMYCIN ON BACTERIAL FLORA OF URINE
 Dosage: 375,000 units every 3 hours for 3 days

Case No.	Name	Organisms Present Before Treatment	Streptomycin Sensitivity (in units per cc)	Organisms present at conclusion of Treatment	Organisms Present 1 Week after Treatment	Organisms Present 2 weeks after Treatment
14	L.S.	B. proteus E. coli K. pneumoniae Strep. non-hem.	8 1 1 8	0 0 0 Strep. non-hem.	0 0 0 Strep. non-hem.	B. proteus E. coli 0 Gram positive cocci
						* Ps. fluorescens
15	S.B.	B. proteus K. pneumoniae Strep. hem. Strep. non-hem.	8 16 8 8	0 0 0 Strep. non-hem.	0 K. pneumoniae 0 Strep. non-hem.	B. proteus 0 Strep. non-hem. * E. coli * Cl. perfringens
16	J.H.	A. aerogenes B. proteus Staph. aureus	less than 0.5 4 less than 0.5	0 0 0	A. aerogenes 0 0	A. aerogenes 0 0 Strep. non-hem. * E. coli
						* Strep. non-hem.
17	L.S.	B. proteus A. aerogenes Gram positive cocci	2 2 -	0 0 0	0 A. aerogenes Strep. non-hem.	B. proteus A. aerogenes Strep. non-hem.
						* Ps. aeruginosa * Staph. aureus

* New organism

TABLE VI

CHANGE IN SENSITIVITY OF ORGANISMS TO STREPTOMYCIN
FOLLOWING TREATMENT

CASE #	ORGANISM	IN VITRO SENSITIVITY (UNITS PER CC.)		TOTAL DOSAGE OF DRUG ADMINISTERED
		PRIOR TO TREATMENT	TWO WEEKS AFTER TREATMENT	
3	B. proteus	4	64	3,600,000 units
	A. aerogenes	32	32	
4	B. proteus	16	16	3,600,000 units
	Strep.non.hem.	16	16	
5	A. aerogenes	128	over 128	3,600,000 units
	B. proteus	16	16	
	Strep.non.hem.	16	16	
6	B. proteus	16	over 128	3,600,000 units
7	B. proteus	8	over 128	3,600,000 units
	Strep.non.hem.	16	over 128	
9	B. proteus	16	8	3,600,000 units
	A. aerogenes	16	16	
10	B. proteus	2	8	3,600,000 units
	Strep.non.hem.	8	less than 0.5	
11	B. proteus	4	over 256	3,600,000 units
	Ps. fluorescens	8	over 256	
	Strep.non.hem.	4	8	
12	B. proteus	4	over 256	3,600,000 units
	Strep. non.hem.	4	over 256	

DISCUSSION

CAPTAIN EDWIN J. PULASKI, MC

As Colonel Shearer and Major Kleinman have shown, the bacterial flora of genitourinary infections in paraplegics is predominantly fecal in origin. The gram negative organisms are still little understood, and we continue to speak of them largely as "groups". Differentiation is complicated and not clear cut. Thus we speak of "proteus groups", "aerogenes groups", "colon" and "paracolon" organisms, etc. The within species variations among these gram negative bacteria is emphasized by their wide range in susceptibility to streptomycin, as indicated in TABLE II. This heterogeneousness of organisms with which we are dealing, and their varied reaction to streptomycin, stresses the need for close liaison with the laboratory. When streptomycin therapy is anticipated, it is only by actual performance of sensitivity tests that we can predict whether or not a presenting poly-bacterial genitourinary infection will be susceptible to streptomycin.

The tables summarizing the results of streptomycin therapy give clear cut evidence of the need for immediate and large doses of streptomycin to achieve success. The gram negative bacteria rapidly become indifferent to the presence of this drug, and unless inhibitory concentrations are attained early, the organisms may become drug-fast. Experience at this hospital suggests that the most susceptible organisms are cleared rapidly from the genitourinary tract by streptomycin, but that more resistant members may be held in abeyance only so long as the drug is given. When the streptomycin is withheld, these resistant species may again flourish unchecked and suppuration may recur. It must be emphasized that reinfection through instrumentation is a constant threat, and that it is imperative to perform these procedures under operating room conditions.

The best results have been achieved when 400,000 units of streptomycin with 1 cc of 1% procaine have been given intramuscularly every three or four hours. Since these results were collected, we have obtained ample experimental and clinical evidence that alkalization of the urine by the administration of sodium bicarbonate or other alkalies greatly enhanced the activity of streptomycin. Streptomycin is extremely more active at pH 8 than in acid urines.

We have confirmed the inactivating effect of cysteine hydrochloride on streptomycin and recommend that a .1% concentration be added to the urines of patients receiving streptomycin to ascertain if the urine is bacteria-free.

NERVE STIMULATION IN PARAPLEGIC PATIENTS
BY MEANS OF BURIED INDUCTANCE COIL.

Preliminary Report

MAJOR JAMES L. POOL, MC, Chief, Neurosurgical Section,
England General Hospital

With a view to initiating useful muscle activity in paralyzed patients unable to walk without artificial aid, an electrical device has been worked out to initiate automatic stepping.

This consists of a small inductance coil buried beneath the skin, having insulated wires connected to electrodes which may be attached to the surface of the desired nerve. To initiate electrical impulses in the nerve, a "primary" inductance coil is placed on the outside surface of the skin; the current in the internal coil can be controlled by altering the distance from the skin or the voltage flowing through the primary coil. The buried coil and wires are completely insulated by a coating of plexiglass. (Similar plastics have been used and implanted permanently in the human body, notably acrylic plates in skull defects). The electrodes themselves consist of nichrome steel wire. While this principle of stimulation is not new, its present application is. The author incidentally has made laboratory tests with this technique before the war.

The implanted coil and its wire leads were sterilized in Bard-Parker solution for 17 hours; 70% alcohol for 4 hours, and were then immersed in sterile saline solution for 1 hour.

In the present instance, a patient was selected with a paraplegic level at T 10. His left arm had been amputated near the shoulder, so that he could not use a left crutch. Walking in braces was also rendered impossible because of extensor spasms in both legs, especially the left. With help in flexion of the left thigh, however, it was felt he might be able to walk. Hence the buried inductance coil was attached to the left femoral nerve and the coil itself implanted at operation beneath the adjacent skin.

Direct contractions of the left quadriceps and indirect contraction of the left iliopsoas muscles can be initiated at will by proper placement of the external or primary inductance coil, or regulation of current through it.

Preliminary tests also demonstrate an effect of reflex spread of induced stimulation, resulting in dorsiflexion of the left toes and foot, which should benefit an automatic gait. Another interesting secondary finding was the demonstration of "Sherrington phenomena", such as ipsilateral facilitation and crossed extensor thrust in the opposite leg, which may also prove beneficial in automatic walking.

While it is far too early to appraise the usefulness of this device, since infection, foreign body reaction, or scarring may render it a failure, it is presented at this conference to stimulate thought along physiological lines for the rehabilitation of these tragic cases. If the method proves successful, selective alternating stimulation of various nerves may well prove of benefit to paraplegic patients, once their spastic contractions have been toned down.

NOTE: Special thanks are due my friends of the U.S. Coast Guard Training Station, Atlantic City, New Jersey, for their intense interest and cooperation in constructing, testing and charting the electrical wave forms of the apparatus in their spare time. I refer to Chief George Barrett and Radioman First Class J.S. Lifford.

(The patient was presented and the action of the stimulator demonstrated).

LUNCHEON

AFTERNOON SESSION

PRESIDING: COLONEL ROBERT H. KENNEDY, MC

THE PROBLEM OF PAIN

(2 papers)

EXPERIENCE AT ENGLAND GENERAL HOSPITAL

LT. COLONEL JOHN E. SCARFF, MC

MAJOR JAMES L. POOL, MC (Presentation by Major Pool)

In 122 paraplegic patients at the England General Hospital, approximately one in four suffered pain; that is, root pain of segmental distribution related to the level of the spinal injury. Only 10 patients, however, or one in twelve, suffered severe pain of sufficient frequency and intensity as to warrant surgical intervention for relief. Of these ten patients, five had wounds of the spinal cord and five of the cauda equina. Root pain, especially in the latter group was often so constant, acute and agonizing that the victims could scarcely move in bed, and characteristically, assumed attitudes or postures which they maintained for hours without a change.

Pain in the spastic group (having spinal cord injuries) might be initiated by the violence of muscle spasms, alteration in posture, or pressure over the spine at the site of the wound. It is perhaps significant that pain and spasm particularly when confined to the abdominal level, were often simultaneous. When the region of the

spinal injury was surgically explored, it was invariably found that sensory roots were not only glued to the cord or dura by dense adhesions, but were often torn or partly shredded, or adherent to rough spicules of bone as a result of fracture. In six cases, treatment consisted of identifying the offending roots at operation, freeing them from scar and then dividing them. When the patient was being operated upon under local anesthesia, it was possible to identify roots by gentle mechanical stimuli before anesthetizing them with novocain and cutting. If general anesthesia were used, the exact level could be checked by electrical stimulation of either dorsal or ventral roots. It was seldom necessary to section more than two sensory roots in a given case, whether the level of the lesion was cervical, dorsal, or lumbar. In five cases, cordotomy was performed; i.e., section of one or both lateral spino-thalamic (pain) tracts at the upper dorsal level.

As to the relative merits of these two methods of surgical relief of pain, it was found that rhizotomy or nerve root section gave immediate relief in all six cases, and cordotomy, complete relief in four of the five; only partial in the fifth. An advantage of rhizotomy is the fact that it provides an opportunity not only of actually inspecting the extent of pathology, but also of freeing nerve roots from scar, bone or dura, especially in the cauda equina levels, so that some motor or sensory improvement can be realized. Cordotomy, while a far simpler procedure, does not offer as much to the patient; indeed, in incomplete lesions, it may jeopardize not only sensory, but what little motor function he may have. However, in some cases, it is the only feasible procedure.

Under the heading of pain, a few words may properly be given to the subject of painful or disagreeable sensations, or dysesthesias, so often complained of by patients having complete as well as incomplete spinal cord injuries. Such dysesthesias are usually described as "tingling", "electrical" or "burning" feelings that seem to shoot up or down the spine, and especially the legs. One patient having an incomplete cervical lesion stated that he suffered darting knife-like pains along the body at various sites, probably due to root traction in this instance, since dense adhesions were found later along the whole dorsal cord. Tingling or burning sensations were associated with 17 complete spinal cord injuries and six incomplete. That is, 23 cases out of a total of 61 cervical and dorsal cord wounds had dysesthesias, and 15 complete and 23 incomplete cord cases had no such dysesthesias. Since these tingling sensations were less often associated with chronic wounds of the cauda equina, and were not always related to root pain, it is felt that they may well be due to abnormal nerve impulses arising within the substance of the proximal (or upper) stump of injured spinal cord. In other words, it is felt that this type

of sensation may be caused rather by the character of the cord lesion than by interruption in cord continuity. This is substantiated by the observation that in patients having complete cord lesions, 17 suffered from these sensations, while 15 did not, regardless of time interval following injury, level of wounds, personality factors or physical condition.

For the sake of completeness, it might be mentioned that a girdle-like band of hyperesthesia over one or two segments was commonly found between the boundaries of normal and anesthetic skin, corresponding to the level of the wound. This hyperesthesia may reflect local root or cord pathology, or both.

In conclusion, it may be said that of 123 paraplegic patients, 44 (or roughly 1/3) had some form of unpleasant sensory disturbance, which ranged from "tingling" in 23 cases to distressing root pain in 10. It is suggested by this survey that diffuse tingling or burning sensations reflect traumatic changes, possibly of irritative character, within the proximal stump of the injured spinal cord. As to the treatment of severe radicular or root pain, it is felt that rhizotomy (or section of nerve roots) offers the patient a better chance for effective relief of pain than does cordotomy, besides offering a chance for neurological improvement, because it requires exploration at the site of injury with lysis of adhesions.

EXPERIENCE AT HALLORAN GENERAL HOSPITAL

MAJOR BENJAMIN B. WHITCOMB, MC

Pain appears to be the second most important complication of a neurosurgical nature seen in the paraplegic patients. Twenty-seven per cent of the one hundred patients reviewed in the paraplegic wards at the Halloran General Hospital have complained of pain of some sort. Seventeen per cent have suffered only slight pain; that is, they have not required medication; the pain has been intermittent and not incapacitating. In seven per cent the pain has been moderate. In this group the pain has been more constant, requires frequent medication but is insufficient to warrant surgery, according to the patient and objectively does not interfere with appetite or activity to any great extent. In the remaining three per cent the pain has been severe; has been associated with insomnia, anorexia and weight loss and warrants surgical relief. Two of the three patients suffering severe pain have lesions of the cauda equina with pain of a typical radicular distribution. A third suffers a lesion of the dorsal cord which is complete. Alcohol injection of the cauda equina for the relief of spasticity in this case of course has no effect on the pain.

MAJOR BENJAMIN B. WHITCOMB, MC (continued)

The surgery of choice in the cauda equina lesions is being considered as being directed to the preservation of all possible nerve function and a rhizotomy or lysis of the affected roots appears indicated. In the case with a complete lesion a cordotomy just above the level of lesion is being considered. It is interesting that, in three patients who have suffered moderate or slight pain, relief has occurred spontaneously with increasing activity and return of function. True also in this group has been the occurrence of pain in those patients of an asthenic type in whom one might expect a lower threshold of pain.

DISCUSSION:

CAPTAIN JAMES C. WHITE (MC) USNR, U.S. Naval Hospital, St. Albans, N.Y.:

Some form of neuralgia is a not infrequent complication of fractures and dislocations of the spinal column, particularly in cervical injuries. Fortunately the major portion of these complaints are relieved by standard orthopedic measures. In thirty-seven cases of more or less complete injuries of the spinal cord in sailors and marines, I have seen only four with severe persistent pain, so severe that it required direct neurosurgical intervention. Therefore it has been a great privilege to come to this meeting and to learn from the Army's far more extensive experience. Our feeling at Chelsea and St. Albans is that severe persistent segmental neuralgia is an indication for exploratory laminectomy. The causes of pain are usually adhesions and injury to the sensory roots caught in the zone of fracture or arachnoiditis. Division of the adhesions and decompression of nerve roots may be all that is necessary to relieve the pain. In an incomplete cord lesion this, plus rhizotomy of severely damaged nerve roots, is all that should be done at the primary operation. Where the transection is complete or when the above measures have failed our neurosurgeons' team at St. Albans has thought it best to do a radical cordotomy. Cordotomy is often successful where rhizotomy fails. No harm can be done by transection of the entire anterolateral quadrant of the cord. A foreign body causing root compression or adhesions is an obvious cause for pain, which may be very severe. I had one such case at Chelsea which was most dramatic. I realize that none of us have had sufficient experience to really know the answers to all the problems of pain after spinal cord injury, and only wish that the war could have concentrated enough cases on one service to have settled this problem.

LT. COLONEL MAYFIELD:

I rise primarily to discuss the subject of sympathectomy for the relief of pain associated with spinal cord injuries. Among a group of 173 patients with spinal cord injuries, three patients have complained of burning pain in one lower extremity. Each of these was a patient with wounds in the region of the cauda equina,

and each had developed symptoms immediately after injury. In every respect the pain resembled causalgia. It was associated with vasomotor disturbances in the extremity, and was greatly affected by emotion. A paravertebral novocaine block of the sympathetic chain was done and gave complete relief of pain immediately. These three patients have been treated by lumbar sympathectomy (lumbar ganglia 1, 2, and 3). Two of them have remained free of pain. The third has had some recurrence of pain. When causalgia develops from wounds high in the thigh or in the lumbosacral plexus, we have found it necessary at times to remove the sympathetic chain as high as D-10 in order to afford relief. We have not felt, however, that the case in question had sufficiently severe symptoms to warrant section of the diaphragm to ganglia D-10-11-12.

It is my opinion that those patients were suffering from true causalgia. Whether the lesions were within the spinal canal or involved the lumbosacral plexus lateral to the canal is not clear. These patients were quite different from those described by Major Pool, who had vague burning sensations in both lower extremities, secondary to wounds of the spine. We have done paravertebral novocaine blocks on several of these without beneficial effects.

It would appear, therefore, that, with lesions which involve the cauda equina, patients may develop pain that is causalgic in character, which involves one lower extremity. In such an event, one should perform a paravertebral novocaine block and if relief is obtained a sympathectomy is justified. It is likely that the number of patients requiring this procedure will be small.

We have felt that pain arising from nerve roots emerging at the site of injury was an indication in most instances of an unstable spine. We believe that this is unquestionably true if the pain is increased by motion. The great majority which have come under our observation, have responded to rest in bed with or without other support or by means of the Stryker frame.

Two patients have been subjected to cordotomy for relief of burning pain in the legs and have been benefited, but not completely relieved.

One patient is now under observation with intense bladder pain for whom a neurectomy is planned. An additional two patients have been admitted with complaint of severe burning pain with phantom phenomenon in the lower extremities. These have been emotional derelicts. They have manifested severe pain throughout all their waking hours, and it has been felt that their emotional status was not compatible with relief by surgical attack. They were, consequently, carried with palliation and it is pleasing to note that they have improved remarkably. They still complain of phantom phenomena in their legs at times when things don't go well, but for the most part, they are well adjusted. I feel that it is

LT. COLONEL MAYFIELD (continued)

well to keep in mind the possibility of a psychic overlay resulting from the tremendous emotional shock associated with sudden bilateral paralysis of the legs.

I was much interested in Major Pool's observation concerning the roll of fibrous tissue in the distal end of the cord in the production of pain. I would like to ask if his observations included electrical stimulation of the distal end of the cord under local to determine if the patient's symptoms could be reproduced.

I would like to take advantage of this opportunity to express my thanks to Colonel Kennody for the invitation to attend this meeting, and also to General DeVoe and his staff at Halloran, and General Chappell and his staff here at England General for a most pleasant and profitable two days. I would also like to commend those responsible for the care of these patients at these institutions for an excellent job.

MAJOR WALTER WEGNER, MC, Newton D. Baker General Hospital:

I should like to mention a case of ours which is only one case and one cannot draw any conclusions from it, but it may give us something to consider. This man was an emotional derelict and complained continually of burning sensation in his extremities. Because of a large bed sore, he had an excision of the scar and from that time on did not complain of pain.

DR. MUNRO:

I see no cases in civil injuries that compare with the severity of land mine and shell wounds. I thought it might be of interest to you that six out of seven cases were returned to full work after being unable to do anything from two to four years. Nothing else was done but to open the dura and leave the dura open. I do not know if that will always work, but certainly it has worked in my cases with considerable success. One man was not completely relieved but was partially relieved and has gone back to part time work with considerable success.

COLONEL CUTLER:

Less than half the patients at Cushing General Hospital complain of pain in the lower extremities. The pain is usually described as a burning generalized pain without special localization. Although in some it is constant, in most it is intermittent. In about half of these cases (19) the pain is so mild and infrequent as to be of no real problem. In the other 21 cases the pain is severe enough to be a source of annoyance both day and night. Pain is the outstanding clinical problem in only two cases. In one of these a lumbar sympathetic block gave almost complete temporary relief of the pain. Accordingly lumbar sympathectomy was

performed recently. It is too early postoperatively to evaluate the outcome. Sympathetic blocks will be done on many of the others who describe a causalgia like pain; sympathectomy will be performed in suitable cases showing relief by block.

The problem of pain is one of the most difficult ones to handle satisfactorily. Narcotics should be denied them insofar as possible because of the question of addiction. In general the pain decreases with time and the patient's pain tolerance is increased by activity, by improvement in the nutritional state and by proper care of the bladder and bowels. Cordotomy should be reserved for the most severe intractable cases.

MAJOR POOL:

Colonel Scarff and I are very much interested in the comments that have come forth. By and large, we are all in essential agreement. If I did not give that impression, it is the fault of my presentation.

In relation to pain due to cauda equina wounds, I know of one patient brought to an Evacuation Hospital in Africa to which no Neurosurgeon was attached at the moment. This man died of pain seventeen hours after being wounded, no operation being done. Nothing was found at autopsy, beyond the cluster of bone chips tangled in the nerve roots of the cauda equina.

I was interested in Colonel Mayfield's discussion about causalgic pain. Two of my patients have had to give up smoking because smoking caused such acute burning sensations in the legs. Two others who had a lumbar block say their pain was made worse. They each had complete cord injuries and even after complete excision of intra-spinal scar, the same burning sensations continued in the legs.

Major Wegner spoke of cordotomy for relief of pain in cases having cauda equina lesions. I feel this is certainly worthwhile if lysis of the nerve roots at the region of the wound fails to relieve pain. It should also be done when lysis is impossible because of the nature of the wound.

Dr. Munro made a very interesting statement about decompression. I have not had enough experience with that sort of work to know how successful it may be. As to decompression, we have hesitated to leave the dura open for fear that scar tissue may invade the intra-thecal space from the adjacent muscles and fascia, and have, therefore, closed or repaired the dural defect in all such cases.

CAPTAIN WHITE:

My answer to this question regarding the relief of leg pain by sympathectomy must be largely on a theoretical basis. In the first place, we must all realize that the effect of sympathectomy in causalgia is not due to direct interruption of pain fibers, as is the case in angina pectoris. In this condition, the cardiac pain fibers are severed when the upper 3 or 4 thoracic sympathetic ganglia are removed by the surgeon, because somatic visceral pain fibers reach the heart along with sympathetic motor fibers through these structures. What then is the effect of sympathectomy on the burning pain of causalgia? In these patients, there is a very striking correlation between their pain and their emotions. They cannot tolerate cold or nervous stimuli of any sort, even the noises of an open ward, the discordant clamor of the radio, or an exciting movie. All this boils down to the fact that any discharge of the autonomic centers in the hypothalamus sets off efferent motor impulses, which in some way must irritate the pain fibers in the peripheral nerves at the point of injury. In England, Doupe, Cullen and Chance (J. Neurol, N.S. & Psychiat, VII, 33, 1945) have stated this in a most convincing article. Furthermore, in Sweden, Granit, Leksell and Skoglund (Brain, 1944, 67, 125) have proved that motor discharges produced by stimulating the anterior root of a spinal nerve set up afferent sensory impulses in the posterior root after an injury of the spinal nerve. It is most dramatic the way this vicious cycle, which in causalgia is set up by exposure to disagreeable physical or psychic stimuli, can be broken by an effective sympathetic denervation of the painful extremity.

LT. COLONEL BARNES WOODHALL, SGO:

In closing the discussion upon this phase of paraplegic therapy, I find myself with little to do except present my own feelings in the matter and make perhaps one minor suggestion for the future. First of all I should like to say that we, as neurosurgeons, can take little responsibility for the magnificent accomplishments of the rehabilitation program that we have seen and talked about these past two days. We are, however, interested in the general administration of paraplegic centers, in the problem of pain, and in the problem of controlling certain abnormal motor responses that are characteristic of a partially or completely isolated spinal cord segment.

The location of neurologic pain in these patients is probably twofold-the first suggests involvement of the sensory roots and the second, involvement of the final common pathway either in the cauda equina or in the paravertebral regions. The suggestion that the scarred proximal cord segment may be responsible for noxious afferent impulses is an interesting but as yet unproven hypothesis.

The sources of pain may be divided from the surgical or remedial point of view into at least two classes. The first has to do with secondary irritation of the intact sensory root or final

LT. COLONEL BARNES WOODHALL (continued)

pathway and the second suggests actual intraneural changes in these structures that may be considered analagous to those changes so well known in more peripherally placed neural structures. Examples of the first group are found in the presence of foreign bodies, or the infection resulting from such material, and scar tissue adjacent to the sensory roots or components of the cauda equina. The second source is not so easy to define but the presence of chronic radicular pain in some cases suggests an intraneural stimulus.

The sources of pain must therefore be attacked directly or by a proximal destructive procedure such as rhizotomy or cordotomy, with the choice of procedure depending upon the distribution of pain. There seems to be a general tendency for spontaneous improvement with improvement in the general physical status of the patient and with ambulation. The mild cases of pain are not easy to control completely; in the severe forms of intractable pain, in the absence of a foreign body source, cordotomy is the operation of choice.

When the direct method of attack is carried out, may I suggest that an effort be made to correlate pathologic changes in nerve roots with those already studied in peripheral nerve tissue.

EXPERIENCE AT ENGLAND GENERAL HOSPITAL

LT. COLONEL JOHN E. SCARFF, MC (Presentation by Lt. Colonel Scarff)
MAJOR JAMES L. POOL, MC

Efforts to alleviate or control the massive spastic contractions which occur so commonly in paraplegic patients have, for the most part, been directed, often with pleasing success, at arresting the spasm without concern for their etiology. Major Pool and I have chosen to make an inquiry into the mechanism causing the spasms, hoping that if the responsible mechanism were found, a method for the relief of spasm might be devised which would not involve destruction of spinal roots and the interruption of segmental reflex arcs. Our inquiry has thus far thrown some new light on the etiology of these spasms, and has given us some suggestions for therapy. The actual results in the relief of spasm have thus far fallen short of our hopes, although it is as yet too early to fully evaluate them.

Since the last war, it has been widely taught and generally accepted, that the reflex activities of the lower isolated segment of a completely sectioned spinal cord in man could be divided into three stages. The first stage was called the flaccid stage and corresponded to the so-called period of "spinal shock". During this phase, reflex activity was completely abolished and the muscles were without tone. This period was said to last from one to three weeks. The second stage, or the spastic stage then appeared and is characterized by an increasing reflex excitability of the isolated segments of the cord developing eventually into massive flexor or extensor spasms. This stage might continue indefinitely if the patient kept generally well. If, however, he suffered from severe sepsis or toxemia from urinary infections or sloughing decubiti, or from general emaciation due to poor nutrition, a third stage might follow, in which there was a progressive wasting of the muscles.

It was also taught and generally accepted, that this hyper-reflex activity was a result of "release" of segmental reflexes in the isolated section of the spinal cord from the inhibitory and controlling influence of the brain.

Our experience with paraplegic patients at the England General Hospital, has not conformed to this generally accepted pattern I have just described. Among our 117 paraplegic patients, we find a wide variation in the clinical picture. For instance, the patients can be divided into four categories on the basis of pain and spasm. There are those who have neither pain nor spasm. There are those who have both pain and spasm. There are those who have pain without spasm and there are those who have spasm without pain.

If we narrow the group of patients for study to those having lesions of the thoracic spine only between the levels of the first thoracic and the 10th thoracic segments inclusive, we still find that patients fall into similar categories. Out of 41 paraplegic patients with lesions in the thoracic cord, there are 33 with spasm and 8 without spasm. This is a striking contradiction to the generally accepted dictum. We then undertook an analytical inquiry into the factors which might have an influence on the occurrence or absence of spasm. This preliminary analysis indicated

FIRST: That there was no relationship between the level of the lesion and the occurrence or absence of spasm.

SECONDLY: That it was a matter of little importance whether the paralysis was complete or incomplete, so far as the occurrence of spasm is concerned.

THIRDLY: That the latent period between the time of injury and the appearance of spasms was quite inconstant and even varied considerably with lesions occurring at the same spinal levels.

FOURTHLY: That there was little or no relationship between the extent of the actual lesion of the cord and the presence or absence of massive spasms.

The above observations have been summarized and assembled in Tables I to VII.

These observations lead one to conclude that the determining factor in the production of massive reflex spasm is not the release of the isolated segments of the cord from the control of the brain. The evidence indicates that the threshold for reflex activity in the isolated segments of the cord is determined not by a constant and predictable physiological factor but by a highly variable and unpredictable factor, pathologic in its nature, inherent in the lesion and acting at the site of injury upon the stump of the divided cord. Furthermore, the evidence suggests that the pathologic process lowers the threshold for reflex activity by a mechanism essentially irritative in character. In brief, this initial study led us to suspect an "irritative mechanism" rather than a release mechanism as the basis of the reflex spasms associated with paraplegia.

On the basis of the above observation, Major Pool and I felt that exploration of the spinal cord at the site of the injury was indicated in all spastic patients. An operative program was therefore planned in which patients suffering with severe spasms and who had been completely paralyzed for a year or longer without evidence of recovery were selected for initial exploration. Major Pool will tell you of our findings in these cases.

LEVEL OF LESION VS SPASMIN CASES OF COMPLETE PARALYSIS

<u>LEVEL</u>	<u>PATIENT</u>	<u>SPASM</u>	<u>TIME INTERVAL- INJURY TO PRESENT</u>	<u>TIME INTERVAL- INJURY TO SPASM</u>
C 7	James	0	6 mos.	—
C 7	George	XXXX	—	2 mos.
T 4	Kaye	0	6 mos.	—
T 4	Bather	XXX	—	1 mo.
T 6	Stewart	0	8 mos.	—
T 6	Rickett	XX	—	1 mo.
T 8	Buhs	X (slight)	19 mos.	—
T 8	Reed	XXX	—	R-5 days L-2 mos.
T 10	Moore	0	8 mos.	—
T 10	Merritt	XXXX	—	L-1 mo. R-2 mos.

II -

LEVEL OF LESION VS SPASM

IN CASES OF INCOMPLETE PARALYSIS

<u>LEVEL</u>	<u>PATIENT</u>	<u>SPASM</u>	<u>TIME INTERVAL- INJURY TO PRESENT</u>	<u>TIME INTERVAL- INJURY TO SPASM</u>
C 7	Avalgia	0 - X	13 mos.	—
C 7	Langel	XXXX	—	4 mos.
T 4	Liwock	0	7 mos.	—
T 4	Kelley	XXX	—	4 mos.
T 6	Rokovich	0	6 mos.	—
T 6	Wishard	XXX	—	6-8 wks.
T 8	O'Grady	0	11 mos.	—
T 8	Medick	XXXX	—	2 wks.
T 10	Baird	0	12 mos.	—
T 10	Cook	XX	—	4 mos.

III -

COMPLETE PARALYSIS VS INCOMPLETE PARALYSIS

IN RELATIONSHIP TO

SPASM

LEVEL	PARALYSIS <u>COMPLETE</u>	SPASM	PARALYSIS <u>INCOMPLETE</u>	SPASM
T 4	Kaye	0	Liweck	0
T 4	Bather	XXX	Kelley	XXX
T 6	Stewart	0	Rokovitch	0
T 6	Rickett	XX	Wishard	XXX
T 8	Buns	X (slight)	O'Grady	0
T 8	Reed	XXX	Wedick	XXX
T 10	Moore	0	Baird	0
T 10	Merritt	XXXX	Cook	XX

IV -

THE LATENT PERIOD

BETWEEN

INJURY AND ONSET OF SPASM

IN CASES WITH COMPLETE PARALYSIS

<u>LEYDEN</u>	<u>NAME</u>	<u>SPASM</u>	<u>LATENT PERIOD</u>
T 4	Bathner	XXX	1 mo.
T 4	Fatchup	XXX	5 mos.
T 6	Rickett	XX	1 mo.
T 6	Mc Millen	XX	5 mos.
T 8	Reed	XXX	1 week (R) 7 mos. (L)
T 8	Martling	XXX	1 mo. (R) 2 mos. (L)
T 10	Merritt	XXXX	1 mo. (L) 2 mos. (R)
T 10	Chilcote	XXXX	2 mos.

V -

THE LATENT PERIOD

BETWEEN

INJURY AND ONSET OF SPASM

IN CASES WITH INCOMPLETE P. R. T. SIS

<u>LEVEL</u>	<u>NAME</u>	<u>SPASM</u>	<u>LATENT PERIOD</u>
T 4	Kelley	XXX	4 mos.
T 6	Wishard	XXX	2 mos.
T 8	Nedick	XXXX	2 weeks
T 10	Cook	XX	4 mos.

VI -

THE RELATIONSHIP

OF

PAIN TO SPASM

Pain Spasm	0 0	Pain Spasm	0 X	Pain Spasm	X X	Pain Spasm	X 0
8		22		11		0	

NO PATIENT SUFFERING PAIN IS FREE OF SPASM

SPASIAIN RELATIONSHIP TOCOMPLETE AND INCOMPLETE LESIONS OF THE SPINAL CORDAS REPORTED BY LATER OPERATIONS

<u>LEVEL</u>	<u>PATIENT</u>	<u>COMPLETE LESIONS</u>	<u>INTERVAL SINCE INJURY</u>	<u>SPASIA</u>
C 7	James	"yellow fibrous ribbon 1 cm"	6 mos.	0
T 4	Keye	"gap 1 cm"	5 mos.	0
T 6	Stewart	"gap 2 cm"	8 mos.	0
T 6	Kesamore	"gap complete"	9 mos.	0
T 10	Moore	"cord completely divided"	8 mos.	0

INCOMPLETE LESIONS

C 7	George	"cord slightly contused"	12 mos.	XXXX
T 5	Kent	"cord bruised"	12 mos.	XX
T 8	Reich	"cord contused"	5 mos.	XXXX
T 10	Cock	"cord looked normal"	8 mos.	XX

OPERATIVE TREATMENT OF SPASTIC PARAPLEGIC PATIENTS

LT. COLONEL JOHN E. SCARFF, MC

MAJOR JAMES L. POOL, MC (Presentation by Major Pool)

PREFACE: Since we were aware that other workers have approached the problem of spastic paraplegia from other angles, such as dorsal or ventral rhizotomy, we adopted another approach, in the hope of alleviating spasms, yet preserving local reflex arcs that might assist automatic walking and prevent trophic changes in the paralyzed portions of the body. We also hoped to learn something about the etiology of spastic contractions that would eventually prove beneficial to all paraplegic patients.

Patients having complete paralysis of the legs averaging twelve months duration or more, with no signs of recovery, and having severe spasms getting progressively worse were selected for operation. In each instance, the patient himself asked for relief because he himself realized his condition was failing both physically and mentally as a result of continued severe spasms of legs, back and abdomen.

The spinal cord was exposed in each instance at the site of injury and for a certain distance above and below this point. Electrical diagnostic studies were carried out on the exposed cord in each case. The methods were similar to those employed in diagnostic studies of brain and peripheral nerve function. As far as we are aware, this is the first time that electrical stimulation has been used to test the function of the human spinal cord in living patients. Eight operations were done on seven patients, six under local anesthesia only, two under general. The principal findings were as follows:

1 - In five cases, the spinal cord was found to be completely divided by the injury, as was expected from pre-operative studies.

2 - In addition, in these cases, the stumps of the spinal cord for approximately 1 inch above and below the injury were involved in dense scar tissue. Moreover, definite pathological changes in the cord itself were apparent for an even greater distance. In the 6th case, while the cord was not found to be divided, an area of softening was noted surrounded by dense arachnoid adhesions. In the 7th case, a 2nd laminectomy (at T 6-L 1) in case 6, there were arachnoid adhesions for a considerable distance below the level of the injury.

Gentle traction on the distal stump of the divided cord and in case number 6 on the cord itself (at the site of adhesions), initiated mass reflex spasms of legs and abdomen in each case. Mechanical stimulation of nerve roots immediately below the level of injury also led to violent spastic reactions. In this regard, the sensory roots appeared to be more sensitive than the motor.

In each operation, electrical stimulation was first applied to the strands of scar tissue joining the ends of the divided cord. In no instance, did this produce pain or other sensation, nor any motor response in legs, abdomen or bladder. It was found that stimulation had to be carried out for a considerable distance on the cord both above and below the actual scar before any response was elicited. This confirmed the visual impression that the cord substance was diseased or non-functioning for some distance beyond the level of division.

Electrical stimulation of the roots yielded the same exaggerated responses as had been obtained by mechanical stimulation. As stimulation was carried out at an increasing distance from the scar, along the surface of the cord, the threshold for responses became lower quite abruptly until responses were readily obtained with minimal stimuli. Stimulation above the lesion resulted in mild tingling sensations or slight local pain, while stimulation below the lesion brought about massive reflex spasm.

Of greatest interest was the fact that maximal reflex activity in legs and abdomen was obtained by stimulation of the cord over the dorsal columns. This was far greater than that due to stimulation over the ventro-lateral portions of the cord. This observation, which was repeatedly confirmed, suggested therapeutic section of the dorsal columns at a low cord level for relief of spasm. This was carried out in one case (number 7) and will be discussed more fully later.

In some cases there was a "reflexogenic" or "trigger" zone in the distal stump of the cord just below the level of the lesion. Impulses arising from this trigger zone were apparently disseminated to more distal segments of the isolated cord, largely by way of the dorsal columns of adjacent pathways (internuncial pathways) capable of descending transmission of nerve impulses.

Turning now to operative procedures: in five cases, the scar tissue involving the stumps of the cord was excised, thus freeing the cord from the effects of traction due to binding scar. In the 6th case, where the cord had not been divided by the injury, both cord and adjacent nerve roots were freed from binding adhesions. In case Number 7, with a complete cord lesion at T 4, both dorsal columns, for reasons already enumerated, were interrupted at the level of T 9-10 and T 12.- L 1.

RESULTS: It is far too soon at this stage to evaluate properly the results of these operative procedures. However, there are some grounds for encouragement. So far, for example, 6 of the 7 patients have been benefited in some degree by operation. We have selected three cases illustrating different aspects of the problem.

MAJOR JAMES L. POOL, MC (continued)

CASE NO. 1 - "B": WIA, 7 October 1944, approximately twelve months ago. GSW T-4, resulting in immediate complete sensory loss and flaccid motor paralysis below his wound. One month after injury, reflex spasms began, increasing in severity so that prior to operation, they had been almost constant and quite violent. He was forced to assume continuously, while in bed, a position in which the thighs were acutely flexed on the abdomen and the legs acutely flexed on the thighs. Even with exaggerated, forceful, and sustained traction on the ankles, the legs could be straightened out only a few degrees. This condition had gradually resulted in a state of permanent contractures at hip and knee. There was no evidence of any return of motor, sensory or bladder function. A moving picture will be shown illustrating his pre-operative status. (Movie)

On 25 September 1945, (over 3 weeks ago) laminectomy was performed under local anesthesia at the level of his injury. The spinal cord had been divided by his original wound, leaving only a tough, gritty strand of scar. This was glued to the dura by dense adhesions, as were the distal and proximal stumps of the cord itself. The tough fibrous scar (after tests showed it conducted no nerve impulses) was excised, after carefully dividing the adhesions all around it and around the diseased ends of the cord. At the lower end of the scar, in obviously diseased spinal cord, was a trigger zone which was removed with the scar. The lantern slide shows a photograph of the fibrous scar after it had been freed from the dura. Microscopic section of this scar shows that no nerve fibre of any kind ran through it. Section through the diseased trigger zone at the lower end of the scar, shows considerable loss of myelin, internal scarring and disorganization and peripheral adhesions.

Three other cases were operated on with similar gross and microscopic findings and similar operative procedures. Of these four, three have been partially relieved of spasms.

CASE NO. 2 - "G": WIA 14 September 1944, over a year ago. GSW cervical spine C 6 to 7. Initial complete flaccid paralysis. Spasms began two months after injury and increased to a point of distressing severity, so violent that the patient stated he was often "bounced about in bed." On turning his head, he always set off violent flexor withdrawal spasms of both legs which spread to abdominal and back muscles. (Movie) One 26 September 1945, laminectomy was done under local anesthesia. The cord was intact. There was slight discoloration and softening at C6 to 7. Around this area were dense adhesions. Gentle traction of the nerve roots, adhesions or even the dura at this level initiated violent spasms of the abdominal, gluteal and leg muscles. Adhesions were freed all around the cord. Following operation, spasms have continued but with this notable difference: The head

may now be turned freely without initiating any spasm. This case shows that traction transmitted to the cord at the level of injury because of surrounding adhesions is capable of initiating spasms. It also illustrates the presence of a trigger zone. Finally, it shows that this reflex activity can be at least partly reduced by releasing the cord from binding adhesions.

CASE NO. 3 - "W": WIA, July 1944, approximately 15 months ago. GSW T-4, complete flaccid paralysis and sensory loss below that level. Spasms in legs and abdomen began one month later, and became gradually worse. Spasms were initiated when the legs were disturbed or when the skin was stroked over the soles of the feet. For the past three months, the patient had been actively disturbed by the spasms, and it was noted that the continued abnormal motion interfered with healing of his decubitus ulcers. The moving picture illustrates his pre-operative status. Because of a superficial skin infection in the region of his wound, exploration of the lesion itself was not possible at this time. It was, therefore, decided to section the dorsal columns at a low level of the cord, since the dorsal columns seemed to be the main channels for dispersion of the widespread impulses that initiated mass reflexes, as tested in previous cases.

On October 14th, 1945, laminectomy was performed from T 10 to T 12 inclusive. The arachnoid membrane was moderately thickened, suggesting a previous widespread inflammatory reaction. Mechanical stimulation of all dorsal roots at this level resulted in mass reflex response on the side stimulated, as did electrical stimulation of the same roots. Electrical stimulation of the dorsal columns yielded the most prompt and active and massive responses, however, suggesting that the dorsal columns or closely related structures served as the main pathway for dissemination of nerve impulses initiating spasms even at this level. The dorsal columns were, therefore, sectioned at T 10 and again at T 12. It was hoped that this would reduce radiation through the cord of sensory impulses not only from the periphery but also from the trigger zone at the level of the higher thoracic cord injury. At the same time it was felt that local reflex arcs might thus be so isolated as to be useful for automatic walking in braces.

Following operation, there has been distinct improvement to date, so that the legs can be passively extended with relative ease compared to the pre-operative condition, and yet the activity of the quadriceps and iliopsoas reflex arcs remains intact as intended.

CONCLUSION:

1. Our studies tend to disprove the widely accepted theory that the mass reflex spasms associated with lesions of the spinal cord are due solely to the release of these segments from controlling influences of the brain.

2. Instead, our studies indicate that the occurrence of mass reflexes seen in these patients are the result of irritation of the cord at the site of the injury by the lesion itself. We believe that the action of the lesion is essentially irritative.

3. We believe that the irritating action of the lesion results in an increased irritability of the cord or lowering of reflex threshold.

4. Our observations indicate that dissemination of irritative stimuli to more distal segments of the cord is transmitted through the dorsal columns.

5. In sum, we believe in an "irritative" mechanism for the production of mass reflex activity in paraplegic patients, as opposed to the generally accepted "release" mechanism.

6. If this thesis be correct, then the logical treatment in cases with a divided spinal cord would be the complete excision of all scar tissue intrinsic and extrinsic, at the ends of the cord. It may well be that some of our inconclusive results have been due to the fact, as indicated by microscopic sections, that excision of scarred cord has been incomplete, and suggest a more radical excision in the future. Finally, "isolation" of lower cord segments may tone down or "tame" mass reflex activity to a useful degree, and shows promise in the one case so far treated in this manner.

EXPERIENCE AT HALLORAN GENERAL HOSPITAL

MAJOR BENJAMIN B. WHITCOMB, MC

The most common and distressing neurosurgical complication in the paraplegic patient is spasticity or paralysis-in-flexion. The upper dorsal and cervical lesions appear to be most frequently associated with the mass reflex. The marked variation in severity of spasticity in individuals with complete lesions at the same level is difficult to explain satisfactorily on a physiological basis and the spasticity occurs in the complete and partial lesions with equal severity. It is interesting to note the improvement in spasticity which many patients associate with change of position from recumbent to vertical, since this fact in itself precludes the necessity for any radical corrective measures in many of the less severe cases. Moreover in incomplete lesions the patient notices diminishing spasticity as the voluntary motor power increases.

At Halloran General Hospital in a review of the 100 paraplegic patients currently on the wards spasticity has been noted in 38. This spasticity has been divided into 3 groups: slight, moderate, and severe. Those considered to have slight spasticity were the patients who have shown some spasticity in one leg or the other which might give some hesitancy in walking if the patient had a partial lesion and was showing recovery; in the complete lesions those who had minor involuntary contractions. Twenty-two of the thirty-eight patients fell into this group. Eleven patients fell into the group considered to have moderate spasticity. Here the spasticity in the ambulatory patient was sufficient to require more than a single cane for walking and in the bed patient the mass reflex was bothersome and frequent enough to overcome the patient's attempts to straighten his legs. These contractions, however, can be overcome sufficiently to permit walking with braces. Severe spasticity is considered to be present in those cases where excessive mass reflex produces contractures or prevents the use of braces or other aids to ambulation. Seven per cent of the patients have fallen into this group. Four of these have shown a partial cord lesion while in the other three a complete lesion of the cord is known to be present.

Treatment of this condition is divided into two distinct categories, with markedly different approach, depending on whether the lesion is complete or partial. Because of this, great care must be exercised in establishing a correct neurological appraisal. This may not be as easy as would appear on initial examination since return of function may be delayed many months or the anatomic condition of the cord may not be known should the dura not have been opened at time of laminectomy or if laminectomy itself were not done

for some suitable reason. Another confusing point is that function may be masked by overpowering rigidity of involuntary contraction.

When it can be established into which group the severe or major spastic paralysis belongs therapy proceeds along one of two lines. 1.) In the incomplete paraplegic with severe spasticity treatment is directed to the extremities themselves and is considered orthopedic, every effort being made in these cases to preserve all possible nerve tissue. However, it is here, when fairly good sensation is present and widespread voluntary motor activity is inhibited from purposeful expression because of the powerful spinal reflex spasms that the extent of surgical interference is difficult to determine. 2.) Major spasticity in the unquestionably complete cord lesions presents much less of a problem. Treatment here is directed to the destruction of neural tissues, chiefly roots or peripheral nerves and is neurosurgical. The production of complete flaccidity which facilitates rehabilitation is readily accomplished by rhizotomy or subarachnoid instillation of alcohol. The latter method has given satisfaction in the two instances in which it has been used at Halloran General Hospital. This procedure is preceded several days before by a spinal anesthesia to isolate the amount of deformity due to spasm from that due to contracture. To instill the alcohol the patient is placed on the side opposite that to be affected with the hips elevated about 15°. A needle is inserted usually between 3rd and 4th lumbar spines and 1 to 3 cc's of 95% or absolute alcohol injected slowly. The patient remains in that position several hours. One week later a similar procedure is done on the other side. Following this procedure orthopedic measures may be required to further correct fixed joint deformities before the patient is able to apply walking braces. The only patient with complete cord lesion and spasticity who has not received this treatment is a new admission who has not been completely evaluated.

Some reasons for preference of subarachnoid alcohol injection to rhizotomy or other radical surgical procedures are 1.) It is a simple bedside procedure with no discomfort to the patient and minimal risk. 2.) It is as effective as rhizotomy and although not necessarily permanent may be repeated, if necessary, with ease. 3.) The level of action may be controlled by regulating the position of the patient and the amount of alcohol injected. 4.) The fact that the induced paralysis is not permanent may on occasion make this method desirable for use in selected cases of partial paraplegics showing uncontrollable spasticity.

DISCUSSION

LT. COLONEL BARNES WOODHALL:

There is no doubt but that the control of abnormal motor responses, such as the so-called mass reflexes, or clonic movements associated with muscle spasm, is probably the most important neuro-surgical problem that we have encountered. The control of mass reflexes is important from two points of view, first, the actual preservation of life and second, to effect the best possible means of ambulation.

I know that you realize that our paraplegic patients were not always as well treated as they are today since it has taken much time and experience to develop the thoughts and practice that has revolutionized their therapy. The control of flexion movements was often in some instances really a matter of life or death and such patients may still be found today. For example, - a patient with bilateral stag horn calculi, a blood pressure of 190/110, eye ground changes, convulsions, decubiti, an abraded anterior chest wall and an unhealed amputation stump, with severe mass reflexes. Any therapeutic attempt upon any of these factors was impossible. For example, - a patient with bilateral compound infected fractures of the femur with mass reflexes. For example, - a patient with a high thigh amputation, open, ulcerated and with frequent hemorrhages, incited by frequent mass contractions. Anterior rhizotomy by the method of Monroe preserved these men for the life saving treatment of their many disabilities.

There is a second and much larger group of patients with disabling hypertonicity that does not allow ambulation. There is a tendency for this reaction to improve with return of function and with efforts at ambulation, and it may be considerably aided by the use of various conservative measures, such as curarization and restraint. The method of alcoholization of the cauda equina described by Major Whitcomb seems quite suited for this period of transition, although I have had no experience with it. What is its effect upon bladder function? Will repeated injections in the more severe forms be as effectual as rhizotomy completed once and for all? There are a few patients with isolated muscle spasm of single muscle groups such as that of the adductors of the thighs. For these, peripheral denervation appeared indicated.

I do not fancy myself highly enough as a neurophysiologist to discuss these fresh and stimulating adventures in this difficult field that have been described by Major Pool and Lt. Colonel Scarff. It seems to me that the crux of the problem lies in the pathologic changes existing in the distal cord segment of these patients with complete cord section and no mass reflexes, granted that sufficient time has elapsed and that a favorable body standard exists for the development of such reflexes. Certainly, stimulation of at least one such case appears indicated. I am not in favor of intensive

LT. COLONEL BARNES WOODHALL (continued)

clinical search for information in this class of patients when existing methods have been proven of value in the treatment of their very disabling complications. The careful formulation of this program, the character of the investigators and our inability to control fully the mass reflexes in patients with incomplete cord lesions justify extension of a study restricted to this neurosurgical center.

MAJOR H. RUSSELL MEYERS, MC, Chief, Neurosurgical Section,
Mayo General Hospital:

May I begin by complimenting Lt. Col. Scarff and Major Pool on their initiative and energy in approaching the serious clinical problem of spasticity in paraplegia by postulating the neurophysiological mechanisms that may be involved and by striking at them surgically? With others here, I shall watch with interest the outcome of the patient whom we saw on rounds today and in whom Major Pool sectioned the dorsal columns (and probably also the ground bundles of the posterior funiculus). There seems to be little doubt but that on this, the patient's fifth postoperative day, he enjoys an appreciable (though not complete) release from the spastic contractures of the lower extremities that obtained prior to operation. His present improvement may turn out in the final analysis to be the consequence of other factors (e.g., diaschisis and/or edema) that implicate the spinal cord as a whole following such surgical procedure rather than a specific consequence of interruption of the posterior funiculi. This and similar questions should be resolvable within a month, at which time it may be presumed that the non-specific factors now present will have ebbed away. In dealing with problems of this nature, neurophysiological experimentation in the human appears to be not only defensible but indispensable to further progress.

At the Mayo General Hospital, 51 patients among our 115 paraplegics presented clinically significant degrees of spasticity. Twelve required a surgical approach to the problem of spasticity and in these altogether eighteen surgical procedures were carried out. These were as follows:

Anterior Root Resection	4	(bilateral)
Obturator Neurectomy	3	(2 bilateral and 1 unilateral)
Tibial Neurectomy (Stoefel)	2	
Tibial Nerve Section and Neurorrhaphy	2	
Tenotomy	3	(2 bilateral hamstring and 1 bilateral Achilles sections)
Alcohol Injection of Spinal Cord	4	
Total	18	

MAJOR H. RUSSELL MEYERS, MC (continued)

In all of these patients, at least one year had elapsed without appreciable improvement from conservative measures directed against the spastic contractures before surgical measures were employed.

I shall not delay you by an evaluation of the merits of these procedures, inasmuch as our experiences with anterior root resection have been salutary and thus coincide with the good results reported by others. The tenotomies in our hands have proven least satisfactory and here again, if I may judge from the observations of others, the results require no comment other than to express the opinion that the procedure appears unphysiological for the reason that it attacks the spastic pattern at the wrong end.

I should like, however, to make a few remarks on the procedure of alcohol injection of the spinal cord which was carried out in four patients by my predecessor at Mayo General Hospital, - Major Spiegel. In two of the cases, he himself confirmed the existence of complete cord interruption and in the other two there existed good grounds from previous operative reports and subsequent clinical observations for assuming the transverse lesions to be complete. These patients presented singular problems in that they had decubiti in such areas as to make laminectomy for anterior rhizotomy unsafe. In addition, the posture imposed by the refractory spasms was such as to interfere seriously with healing of the decubiti. Accordingly there was noted a progressive undermining of the patients' general health by the persistence of the decubiti. With the approval of the surgical consultant, Major Spiegel dealt with the spasticity by injecting $1\frac{1}{2}$ - 2 cc quantities of absolute alcohol directly into the spinal cord through needles introduced at the T 9-10, T 10-11 and/or T 11-12 interspaces. The injection in all four cases was below the level of original lesion. In these patients a flaccid state immediately supervened and lasted for 4 - 8 weeks. The spasticity thereafter gradually returned. Meanwhile, nursing care was greatly facilitated, the Stryker frame could be utilized, healing of the decubiti proceeded satisfactorily, and the patient's general condition improved, making it then feasible to employ other surgical measures. Major Spiegel feels that the level of injection can be selected in such a manner as to avoid making a lower motor neurone bladder of one in which reflex automaticity has been established.

Throughout this entire discussion on spasticity in the paraplegic patient, I have been impressed with the thought that the most challenging matter with which we are faced is the formulation of a useful concept as to what the nature of spinal shock really is. It is true of course that the outstanding phenomena relevant to it have been known since Marshall Hall introduced the term, but thus far our knowledge of spinal shock has been largely of a descriptive character. We sorely lack a satisfactory dynamic account, not only of the period of depressed reflexes to which the term more strictly applies, but of the determinants of its recession and its familiar displacement by the supervention of segmental-intrasegmental auto-

MAJOR H. RUSSELL MYERS (continued)

maticity. It is known that the period of flaccidity and hypotonia is generally, though not strictly, of greater duration as we ascend the phylogenetic scale. In the frog it lasts for 3 - 20 minutes; in the cat for upwards of an hour or more; in the dog for several days; in man for several weeks or months and perhaps enduringly. What is it that happens during this period that determines when and why the flaccid hypotonic areflexic state will regress?

The only dynamic account of spinal shock that has held much favor is that conceived by Hughlings Jackson and elaborated upon by Sherrington and his collaborators. Its most recent endorsement has been made by Liddell. In this familiar account the areflexic state is regarded as due to the loss of suprasegmental excitatory impulses. The later-supervening periods of mass-reflex and discrete hyperreflexia have been explained as the result of the loss of suprasegmental inhibitory impulses. A serious objection to this hypothesis is that it is an ex post facto account. It conveniently "polarizes" the influences of the suprasegmental apparatus, seizing now upon one process (e.g. excitatory) and excluding the other (inhibitory) and later reversing the processes as the needs of the case require. It fails to allow for the physiological circumstances that both excitatory and inhibitory volleys are continuously imposed upon the lower levels by suprasegmental and intrasegmental mechanisms. In its present form, the hypothesis could quite as readily be invoked to explain the phenomena if the actual sequence of events as we encounter them, i.e., the flaccid state followed by the spastic, had happened to be juxtaposed. It fails to tell us why the one precedes the other and in what segmental autonomy consists.

In considering the neural mechanism of another but related phenomenon - that of parkinsonian rigidity - I expressed in 1941 a degree of discontent with the prevalent notion and today we have heard Lt. Col. Scarff and Major Pool express a similar unrest. Their tables suggest that in paraplegics no correlations obtain between the degree of flaccid and spastic states and (a) the degree of completeness and incompleteness of the lesion; (b) the level of the lesion, excluding the conus; and (c) the length of time between injury and the appearance of spasticity. Their unrest with the "release" doctrine has led them tentatively, at least, to propose an "irritative" theory in which cicatricial pathology plays an essential role. In support of this motion they cite the benefit that followed the removal of such scars in two of their spastic patients. Their account seems to me inapplicable to those cases in which apparently similar scars are present in flaccid patients. A needed supplement to their theory is a qualitative account of the differences in scars that subtend the flaccid state in one case and the spastic in another.

In theory, at least, it would appear that if we could but apprehend some broad unifying principle, we might fit together into

a meaningful whole (1) the familiar clinical phenomena of spinal shock and spastic paraplegia; (2) the gross and microscopic pathological findings seen in traumatized cords; (3) the numerous experimental demonstrations that relate to cord section; and (4) the facts supplied by neuroembryology on the determinants of the acquisition of functional neural patterns. Such a unifying principle, I believe, is available and for several years has been known to biologists as "physiological gradients". Its capacity to account for clinical phenomena has not generally been appreciated by practical medical men. It may be recalled, however, that its utilization by Walter Alvarez to explain intestinal movements, vomiting, etc., measurably improved our understanding of gastrointestinal functions.

This is not the time to enter upon a discussion as to what physiological gradients are and of their role in the acquisition of neural patterns. The studies of Child, Detwiler, Coghill and Kappers in this connection merit more attention than we could give them in another two-day symposium. What I would like to suggest, however, is that an inquiry into gradients as they apply to spinal shock may well prove profitable. In an account cast in such terms, we would regard the flaccid state as a manifestation of disorganization (more or less transient) of neural patterns, the functional integrity of which depends upon an acquired hierarchy of dominant and subordinate gradients. The spastic state we would regard as one which can supervene only if and when a new hierarchy below the level of transection has been acquired. The mass reflex we would regard as a transitional state, physiologically (and frequently also temporally) intermediate between flaccidity and spasticity, comparable in many respects to the diffuse neural patterns of the embryo and infant. Finally, the account would propose that whether or not flaccidity gives way in a particular case to spasticity depends upon whether the cord is enabled to "experience" afferent impulses (interoceptive, exteroceptive and proprioceptive) of such character as to determine the establishment of a new hierarchy of gradients. It would explain quite satisfactorily what I have noted in dog experiments and in a single human experiment that when the cord is interrupted at an upper thoracic level, the spastic state can be abolished for a period by making a new transection at a lower level. Something of the same sort occurred in Major Spiegel's cases to which I have referred.

All this suggests a further consideration in respect to paraplegic patients, that of a more complete knowledge of the actual damage to the cord than we generally allow for. If, for example, the sum total of microscopic damage to the cord at regions remote from the more dramatic level of injury were such as to limit or significantly exclude the play of afferent and internuncial impulses that lay the ground work for the acquisition of new gradients, then the appearance of spasticity would be delayed, perhaps enduringly.

The point is clear that we cannot reliably estimate the pathology of a patient's cord from mere inspection through a laminectomized field. In his studies of spinal concussion, Hassin has described multiple myelomalacic lesions, scattered widely from the level of trauma. Again, the meandering character of many hematomyelias is a familiar enough finding in the traumatized cord. Of these pathologic processes we have heard nothing during this symposium. Are we to suppose that they do not exist in our patients; or that if they do exist they are not important determinants of the clinical manifestations? I think not. On the contrary, I incline to the belief that the seeming contraindications to which Lt. Col. Scarff called our attention this afternoon will prove, as soon as the pathophysiology of the paraplegic cord is accurately described, to amount to consistent correlations. Looking to this desirable goal, the biologists' concept of physiological gradients is recommended.

DR. MUNRO:

I had not intended to speak again, but I would be ashamed of myself if I did not take this opportunity to congratulate Colonel Scarff and Major Pool on the piece of work they have just reported. It takes great courage to depart from tradition as they have done. I would like, however, to make certain comments that seem to me to be apropos. Sherrington's experimental work is classical and fundamental. I doubt very much whether anything can be done that will contradict the principles he enunciated as the result of it. Perhaps some of the details will have to be altered but I believe that fundamentally his conclusions will continue to apply and are unavoidable. What Major Meyers had to say is extremely important and I fully agree with him. I should like to point out as well that it is generally agreed that the presence of an infection, an open wound, malnutrition, exhaustions, anemia and the like will greatly change the time of appearance and the characteristics of the mass reflex. This has been my experience also. This, and the fact that many, if not all, of the authors' cases had either bedsores or genitourinary tract infection or both, makes the interpretation of their observations difficult. These complications must be eliminated before the authors' results can be accurately evaluated. I believe too, that their statistics are capable of interpretations that disagree with instead of support their conclusions. I think they should be checked and possibly revised from that point of view. It appeared to me also that they did not separate the patients with anatomical from those with physiological transections or with non-transecting cord injuries in their consideration of the significance of involuntary spasmodic movements. This confuses any study of their causation. For the present at least, I feel that more progress will be made if such a study is limited to patients with proved anatomical transections. These are the only ones who correspond to the experimental spinal animal of the physiologists and hence the only ones that may be expected to show changes comparable to those accepted at present as standard. After human physio-pathology has been thus checked against

DR. MUNRO (continued)

animal physio-pathology the more complicated matter of patial cord lesions can be attacked.

MAJOR BORIS PETROFF:

Having been a ward surgeon and urologist to a ward of 87 spinal cord injury patients at Newton D. Baker General Hospital for the past year, I can appreciate the problem of spastic patients. While their suprapubic cystotomies are being closed and a urethral catheter is in place these spastic patients are apt to void around the catheter, thus keeping their beds wet and creating a difficult nursing problem. As a palliative, Tincture of Belladonna, minims 15 to 20 given three times a day, has been found useful. This spastic contracture of bladder is intrinsic in bladder itself and has no connection with spasm of abdominal muscles as proven by cystometric studies.

As Dr. Munro has said, spasticity of these patients is aggravated by their internal condition, thus our patients with renal calculi were markedly spastic until the calculi were disposed of.

Of the 87 patients with spinal cord injuries, 40 came to us with suprapubic cystotomies. All these are closed now and 25 of the 40 are voiding; three of these having had transurethral resections of bladder neck. All have tidal drainage. The remaining 15 will void in time and may need transurethral resections later on.

A word about streptomycin which has been the most useful new drug in the urinary infections of these paraplegic patients. We first started using it in April 1945 just before the paraplegic conference of the Fifth Service Command held at Newton D. Baker General Hospital in May 1945. Streptomycin proved to clear up and control urinary infection due to gram negative bacilli which did not respond to penicillin. However, just as the findings of Halloran General Hospital given here today have proven these bacteria develop strains resistant to streptomycin. Some strains of Aerobacter Aerogenes and B. Proteus can now withstand upward of 600 units of streptomycin per cc. However, even if it is impossible to render the urine sterile by raising the urine level to that height, clinical improvement does take place in reducing the morbidity of pyelonephritis and epididymitis as well as occasional bacteremias. Without streptomycin many of our patients would not be alive today.

In all due credit to the neurosurgeons who have done such wonderful things to paraplegic patients, it is still the urologist who keeps them alive long enough for the neurosurgeon to put in his good work.

COLONEL CUTLER:

Of the 86 patients at Cushing General Hospital, 41 exhibit spasticity of varying degree. This includes both partial and complete

lesions. Twenty of these cases are considered to be only mildly spastic - that is, the degree of spasticity is not great enough (a) to bother the patient as he lies in bed or as he sits in the wheel-chair; (b) to interfere with the application and use of walking caliper braces. Fifteen of these cases are considered moderately severe because their spasticity interferes with application and utilization of braces although not preventing care of patients in bed and wheel-chair. Six of these cases are considered severe because the spasticity is of such degree as to interfere with the bed care of the patients and to be a constant source of difficulty and discomfort to the patient; in these six the problem of spasticity is the major consideration to the patient. In one case anterior rhizotomy was performed late in the course of the spasticity as a life saving measure after the terrific flexor spasm of the thighs and knees had made proper feeding and retention of food impossible. The operation effectively relieved the spasticity and solved the nutrition problem; unfortunately the patient now has a completely atonic bladder, a result of this operation which can be avoided.

The most frequently encountered types of spasm which cause the patient difficulty are (a) adductor spasm (b) hamstring spasm (c) gastrocnemius and soleus spasm (d) gluteus medius spasm. (Fortunately the marked spasm of the psoas muscles as described in the case above have been encountered only once in this group although several cases have shown it to a less extent).

In one case adductor spasms have been relieved entirely by bilateral high obturator nerve section combined with division of the tendon of the adductor longus in the upper thigh. In three other cases simple bilateral section of the obturator nerve has given a measure of relief but is not nearly as effective as the combined neurotomy - tenotomy. Achilles lengthening by stoppage tenotomy has been performed on two cases with good early results; the outcome is still questionable in these cases inasmuch as they are not yet ready for walking calipers.

Division of most of the hamstrings has been effective in partially relieving flexor spasm of the lower leg, while Achilles tenotomy, combined with division of the motor branches of the tibial nerve at the knee, has greatly aided marked talipes equines in one patient.

Gluteus medius tenotomy accomplished just distal to the greater trochanter is of value in relieving spastic internal rotation of the hip which often accompanies adductor spasms.

Those cases which continue to show flexor spasms of the thigh to a distressing extent will be subjected to psoas tenotomy through a high thigh postero-medical incision.

It is felt that most spastic cases can be handled by combination tenotomy-neurotomy procedures as outlined above. This we

COLONEL CUTLER (continued)

consider to be the method of choice as compared to rhizotomy for the following reasons:

1. Simplicity of performance without subjecting often debilitated patients to the major surgical procedure of rhizotomy.
2. This method does not preclude future useful voluntary motion in the event of re-innervation of musculature; this is of importance in the partial paraplegics with spasticity who may regain some function.
3. Spasticity itself tends to gradually become less marked with the passage of time. Tenotomy-neurotomy procedures should be sufficient even in serious cases to tide them over until there is spontaneous relief of spasticity.
4. Rhizotomy can be reserved for any failure of the simpler method in severe persistent spasticity.

LT. COLONEL JOHN E. SCARFF:

The question has been raised as to the nature of "spinal shock" in our concept. There are several ways of looking at the period of so-called spinal shock, which is characterized by flaccid muscles and absent reflexes immediately following transection of the cord.

Spinal shock, for instance, may be regarded as the period when edema of the cord at the site of the injury is greatest. At this time physiologic isolation of the lower segments of the cord is certainly maximal. If isolation of the lower segments and their "release" from the influence of the brain were responsible for massive spasm one might expect spasms to appear at this time. Instead, when isolation is most complete the reflex activity is slightest.

Mention was made by one of the discussors of the fact that scar tissue may be inside the cord as well as outside of it. We are well aware of that fact, and indeed Major Pool has stressed it in the presentation of one of the cases. The limited improvement which has followed in this case may well be due to the fact that while extrinsic scar has been thoroughly excised, the intrinsic scar within the cord has not been completely removed. This, of course, argues for a more radical amputation of the damaged stump and will be practiced in our future cases.

Dr. Munro has argued that we have not disproven the dictum long held, that massive spasms develop in all cases where the spinal cord has been transected. He stressed the point that we had only proven that in some cases the onset of spasm might be delayed until at least 19 months after the accident. I think that this places a very narrow interpretation upon the facts. I would say that

LT. COLONEL SCARFF (continued)

it remains for him rather to explain why the spasms did not appear for 19 months or more after release of the lower segments of the cord had taken place if "release" is the determining factor in the appearance of these spasms.

MAJOR WHITCOMB:

The bladder in these patients, before treatment, showed such frequent spasmodic contraction that the patients were constantly wet. After alcohol instillation the bladder capacity has been found to be increased and although the function of the bladder is altered as far as the patients are concerned, they are much pleased with the end results. I wonder how much of the poor bladder function, prior to alcohol injection, is due to spasticity of the bladder and how much is due to the involuntary contraction of the abdominal muscles. We have attempted to spare the abdominal muscles for use in voiding and defecation by keeping the alcohol low in the caudal sac, affecting just the lower lumbar and sacral nerves. I would like to stress again the importance that we feel in the type of cord lesions present in these patients having spastic contractions. We feel that the partial lesions have done so well that we should do everything possible to preserve all nerve function and consider them almost completely an orthopedic problem. In the complete lesions we have no hesitations in destroying the lower cauda equina to relieve the spasm.

One word about the work Colonel Scarff and Major Pool have done. We know that the normal response in transection of the cord is to have some increase in the reflex action below the level of the lesion. Therefore, we must consider prolonged flaccidity as abnormal as the hyperactivity of the mass reflex producing the spastic contractions which are under discussion. We agree with Colonel Scarff and Major Pool that this increased mass reflex must be due to some irritating focus, but since the prolonged flaccidity is just as abnormal, we hope in their investigations they may be able to determine in some of these cases why there is such prolonged spinal shock. We have noted in three cases a changing level of paralysis, which is ascending and not descending and felt that it might be due to thrombosis of the spinal vessels. This might be a factor in the distal segment of these cases having prolonged spinal shock, or permanent flaccidity.

COLONEL R. GLEN SPURLING:

This whole conference has been an instructive and worth while experience. The original work by Lt. Col. John E. Scarff and Major James L. Pool has been a splendid example of carefully controlled clinical research.

I feel, however, that a word of warning should be spoken. We are not privileged to try out hastily-formulated ideas on American soldiers. Most of us had better stick to generally accepted principles; for there otherwise will be tremendous repercussions.

This work is an illustration of that point. Fully nine months ago Major Pool talked over with me in detail his notions about spasticity, mass reflexes and mechanical walking. As a matter of fact, he had done considerable work upon the problem before entering the Army and he has been critically observant of the problems presented by the paraplegics ever since. This work, therefore, has a sound background, both experimental and clinical, and the discussions that you heard here today are encouraging in the extreme and should be pursued further. For instance, it seems to me mandatory that a patient with a complete cord lesion must have the distal segment of his cord explored and carefully studied in order to further clarify the problems mentioned here today.

May I warn the neurosurgeons present that no effort should be made by them to amplify or to collaborate this work. It should be left strictly in the hands of these observers, and when they are ready to give us unequivocal evidence of its clinical application, then the rest of us can undertake it.

In summarizing the presentations that we have heard today from the various authors on spasticity, it seems to me that several points stand out: first, any spastic who can be made ambulatory has a good chance of spontaneous improvement; therefore, any surgical procedures to relieve spasticity should be reserved for those cases in which spasms are so severe that ambulation is prohibited; second, the patients for treatment are distinctly divided into two groups, (a) those with complete cord injury and (b) those with incomplete ones.

In those that are complete, an effort should be made to make them ambulatory by the simplest procedure possible; that is, peripheral nerve section, such as the obturator nerve for adductor spasm. If this fails, then one should consider operations such as rhizotomy and intrathecal alcohol. In the incomplete group, no destructive operation should be done until sufficient time has elapsed to be sure that there will be no further clinical improvement. That is always a matter of two or three years. In the meanwhile, there has accumulated a good deal of evidence that the curare is of distinct benefit and I would certainly recommend that each of you look into its possibilities. Considerable experience has been accumulated on this method at the McGuire General and Nichols General Hospitals.

The other subjects of the conference have already been adequately summarized and I shall not touch upon them further.

ADJOURNMENT

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